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(71) Applicant: **Hitachi, Ltd.**
Chiyoda-ku, Tokyo 101-8010 (JP)

(72) Inventor:
Saito, Takeshi,
Intellectual Property Group
Chiyoda-ku, Tokyo 100-8220 (JP)

(74) Representative:
Beetz & Partner
Patentanwälte
Steinsdorfstrasse 10
80538 München (DE)

(54) **A wireless tag, its manufacturing and its layout**

(57) To provide a wireless tag having a wide band, a microstripline of a half wavelength type is used and IC is built in between an antenna (13) and an earth (15) conductor, and a middle point (18) of the antenna (13) and the earth (15) conductor are connected.

FIG. 3A

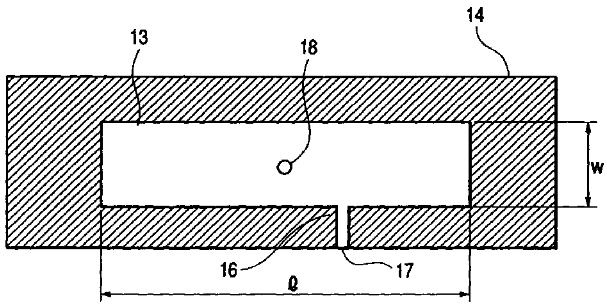


FIG. 3B

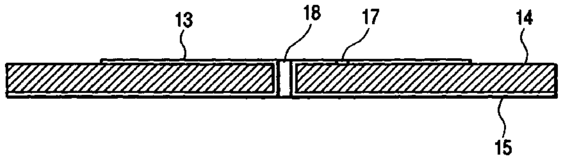
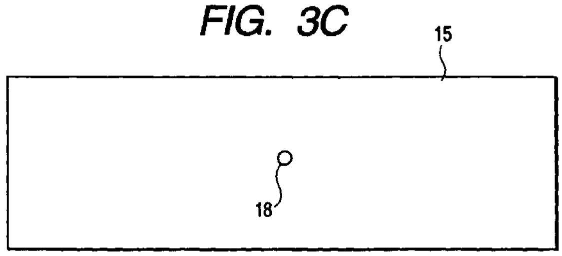


FIG. 3C



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a wireless IC tag using a radio frequency of sub-microwave band having no battery.

[0002] A detailed description is given of a conventional wireless IC tag using the radio frequency band and having no battery in Shinichi Haruyama, "Technologies for microwave ID card system", the supplement of Japanese magazine "Transistor Gijujtsu" published by CQ Publishing Co. Ltd., pp. 21-29, May 1992. In a rectenna (circuit comprising an antenna and a rectifying circuit) of a wireless IC tag described in the paper, there is introduced an antenna as shown by FIG. 1 comprising a series connection of a half-wavelength resonator and a shottky barrier diode. FIG. 1 shows the rectenna circuit, numerals 1 and 2 designate quarter-wavelength antennas, numeral 3 designates a shottky barrier diode, numerals 4 and 5 designate inductors, numeral 6 designates a condenser and numeral 7 designates an output terminal. Power of microwave received by the 1/4 wavelength type antennas 1 and 2 is rectified via the shottky barrier diode 3 and the inductor 5 and is accumulated in the condenser 6 as direct current and is outputted from the output terminal 7 as necessary. Further, there is described an example of utilizing a rectangular microstrip-patch antenna in AIM Japan, "Technologies and applications for data carrier" published by THE NIKKAN KOGYO SHIMBUN,LTD., pp. 22-25, Oct. 1990. FIGS. 2A, 2B and 2C show the example of the rectangular microstrip-patch antenna in which FIG. 2A is a plane view, FIG. 2B is a side view and FIG. 2C shows a rear face. In FIGS. 2A, 2B, 2C, numeral 8 designates a rectangular patch, numeral 9 designates a dielectric member, numeral 10 designates an earth conductor, numeral 11 designates a feed line and numeral 12 designates a feed point. A signal of microwave inputted from the feed line 11 is resonated by a frequency determined by a length "ℓ" of a side of a square shape including the feed point 12 of the rectangular patch 8. According to these antennas, when loss of member is reduced to reduce loss of the antenna, Q as the resonating circuit becomes high and a matching frequency band is narrowed. When Q of the resonator is increased, it is difficult to widen the matching frequency band of the antenna.

[0003] According to a wireless IC tag, voltage generated by rectifying current is changed in accordance with a distance between the wireless IC tag and an interrogator antenna and when the wireless IC tag becomes proximate to the interrogator antenna, the rectifying voltage is rapidly elevated. Therefore, in view of withstand voltage of IC, a voltage value is devised to maintain at a predetermined value or lower by a voltage limitter comprising transistors connected in multiple stages in Japanese Patent Laid-open (Kokai) No. Hei 8-185497. Further, a result of communicating with the wireless IC tag is produced by data of the wireless IC tag absorbed from the interrogator.

[0004] With regard to a structure of a dipole antenna for electrically connecting and packaging an antenna of a wireless IC tag and an IC circuit, in "manufacturing method for wireless tag" disclosed in Japanese Patent Laid-open (Kokai) No. Hei 10-32214, there is described a method of mounting a structure in which IC is attached to a strip-like antenna having a lead frame structure and an IC attaching portion thereof or a total thereof including the antenna is integrated by a mold technology such as transfermold.

SUMMARY OF THE INVENTION

[0005] According to the conventional technologies, it has been difficult to widen a matching frequency band by promoting a sensitivity of the antenna of the wireless IC tag. It is an object of the present invention to achieve wide band formation without deteriorating the sensitivity of an antenna to thereby facilitate to manufacture the antenna by promoting the yield against the manufacturing dispersion by constituting the wide band formation of the antenna.

[0006] It is another object of the present invention to realize a circuit constitution in place of a low voltage circuit maintained at predetermined voltage by wastefully consuming current by using a transistor, a zenner diode or the like, for carrying out operation of confirming transmittance of data between a wireless IC tag and an interrogator by using power dissipated in the previous low voltage circuit without checking and determining by the data of the wireless IC tag read by the interrogator.

[0007] It is another object of the present invention to manufacture of a wireless IC tag of an integrated type by filling and molding a mold material of transfer mold or the like as a dielectric material of an antenna in a microstrip-line constitution while ensuring electric connection between IC and the antenna and ensuring also mechanical strength in the antenna for the wireless IC tag in the microstrip structure comprising an earth conductor plate constituted by a lead frame and an antenna conductor.

[0008] In order to widen a matching frequency band without deteriorating the sensitivity of an antenna of a wireless IC tag, there is achieved wide band formation by double tuning by constituting an antenna of a double tuned type in which quarter-wavelength antenna resonators in a microstrip constitution are subjected to mutual inductance coupling by an impedance element comprising a common inductor. For that purpose, there is adopted an antenna structure for grounding a middle point of a half-wavelength antenna by using a through hole conductor with an earth face of a microstrip substrate or a lead frame conductor. There is constructed an integrated structure by mechanically and/or electrically connecting IC to a surface of an antenna constituted by a lead frame conductor on a side of a earth face by using an insulating adhering agent or a conductive adhering agent and pressurizing and solidifying a mold member for transfer mold of the lead frame integrally connected electrically and mechanically to an earth conductor constituted by the lead frame conductor by a conductor for grounding at a middle point of the antenna.

[0009] In order to make rectified voltage generated at the rectenna circuit constant voltage, according to the present invention, LED (Light Emitting Diode) is introduced, and constant voltage formation of the circuit is achieved by utilizing rapid rise of forward direction voltage of the positive characteristic of LED. Generated power increased as the wireless IC tag becomes proximate to an antenna of an interrogator, brings about an increase in current in the forward direction of LED, increases light emitting intensity of LED and the circuit maintains voltage applied on an IC circuit constituted by CMOS or the like at a predetermined value. The light emitting phenomenon at this occasion indicates that the interrogator makes access to the wireless IC tag or can make access thereto. At this occasion, the IC indicates a drivable state or a driving state and constitutes a criterion of in-operation of recognizing the wireless IC tag or finish of operation by a congestion control. Further, by setting and disposing a logic circuit in the IC circuit, the logic circuit can be used in various signals for positively controlling the light emitting state of the diode and knowing the state of the wireless IC tag via the logic circuit.

[0010] By press forming of a lead frame flat plate, the lead frame flat plate is formed in a shape of a cross having a connection conductor with an earth conductor at a middle point portion of a half-wavelength antenna formed in a short strip shape, further formed with a connecting portion for connecting to match with the IC circuit between a middle point of any of sides and an opening end of the antenna in the longitudinal direction of the antenna, further connected with a circuit of the wireless IC tag or a terminal for inputting/outputting signal of IC arranged at the middle point portion of the antenna by a technology of wire bonding or the like and at the same time, by connecting the circuit of the wireless IC tag or the ground terminal of the IC to the antenna conductor by the technology of wire bonding, the antenna portion is formed. From the lead frame flat plate constituting the earth conductor of the antenna of the microstrip-line formed by the same lead frame flat plate, there is formed an earth conductor portion in a shape of a box having an area wider than the face of the antenna and a shallow depth by a hexahedron structure one face of which is opened and which is formed by a press and the ground conductive portion is mechanically and electrically connected thereto at a connecting conductive portion of the earth conductor of the antenna portion such that the circuit or the IC of the wireless IC tag constitutes a face on the side of the earth conductor and such that the antenna portion and the earth conductive portion are kept in parallel with each other and a mold material used in transfermold or the like is filled in a gap of parallel portions of the antenna and the earth conductor portion and the total is formed integrally.

[0011] Further, the wireless tag constituted by the microstrip-line receives radio wave from the antenna side and accordingly, the earth conductor on the rear face may be arranged to be opposed to the radio wave radiating side. Therefore, in the case in which the wireless tag is arranged to a distributed article or the like, the earth conductor side may constitute an adhering face.

[0012] These and other objects and many of the attendant advantages of the invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013]

FIG. 1 shows a conventional example of a rectenna of a tag;

FIG. 2A is a plane view of an example of a patch antenna using a microstrip-line;

FIG. 2B is a side view of the example of the patch antenna using the microstrip-line;

FIG. 2C is a rear view of the example of the patch antenna using the microstrip-line;

FIG. 3A is a plane view of a surface of an antenna of a wireless tag using a microstrip-line according to a first embodiment;

FIG. 3B is a sectional view of a side face of the antenna of the wireless tag using the microstrip-line according to the first embodiment;

FIG. 3C is a sectional view of a rear face of the antenna of the wireless tag using the microstrip-line according to the first embodiment;

FIG. 4 is an equivalent circuit of the antenna according to the first embodiment;

FIG. 5A is a plane view of an antenna for a wireless tag according to a second embodiment;

FIG. 5B is a sectional view of a side face of the antenna for the wireless tag according to the second embodiment;

FIG. 5C is a plane view of a rear face of the antenna for the wireless tag according to the second embodiment;

FIG. 6 shows a constitution of an antenna for a wireless tag according to a third embodiment;

FIG. 7 shows a constitution of an antenna for a wireless tag according to a fourth embodiment;

FIG. 8A is a plane view of an antenna face of an antenna for a wireless tag according to a fifth embodiment;

FIG. 8B is a sectional view of a side face of the antenna for the wireless tag according to the fifth embodiment;

FIG. 8C is a sectional view of a side face of the antenna for the wireless tag according to the fifth embodiment;

FIG. 9A is a plane view of an antenna for a wireless tag according to a sixth embodiment;

FIG. 9B is a sectional view of a side face of the antenna for the wireless tag according to the sixth embodiment;

FIG. 9C is a plane view of a rear face of the antenna for the wireless tag according to the sixth embodiment;

FIG. 10A is a plane view of a wireless tag according to a seventh embodiment;

FIG. 10B is a sectional view of a side face of the wireless tag according to the seventh embodiment;

FIG. 11A is a plane view of a wireless tag according to an eighth embodiment;

FIG. 11B is a sectional view of a side face of the wireless tag according to the eighth embodiment;

FIG. 12A is a plane view of a wireless tag according to a ninth embodiment;

FIG. 12B is a sectional view of a side face of the wireless tag according to the ninth embodiment;

FIG. 13A is a plane view of a wireless tag according to a tenth embodiment;

FIG. 13B is a sectional view of a side face of the wireless tag according to the tenth embodiment;

FIG. 14A is a plane view of an antenna for a wireless tag according to an eleventh embodiment;

FIG. 14B is a sectional view of a side face of the antenna for the wireless tag according to the eleventh embodiment;

FIG. 14C is a plane view of a rear face of the antenna for the wireless tag according to the eleventh embodiment;

FIG. 15A is a plane view of an antenna for a wireless tag according to a twelfth embodiment;

FIG. 15B is a sectional view of a side face of the antenna for the wireless tag according to the twelfth embodiment;

FIG. 15C is a plane view of a rear face of the antenna for the wireless tag according to the twelfth embodiment;

FIG. 16A is a plane view of an antenna for a wireless tag according to a thirteenth embodiment;

FIG. 16B is a sectional view of a side face of the antenna for the wireless tag according to the thirteenth embodiment;

FIG. 16C is a plane view of a rear face of the antenna for the wireless tag according to the thirteenth embodiment;

FIG. 17A is a plane view of a wireless tag according to a fourteenth embodiment;

FIG. 17B is a sectional view of a side face of the wireless tag according to the fourteenth embodiment;

FIG. 17C is a plane view of a rear face of the wireless tag according to the fourteenth embodiment;

FIG. 18A is a plane view for explaining conductor formation of a wireless tag according to a fifteenth embodiment;

FIG. 18B is a side view for explaining the conductor formation of the wireless tag according to the fifteenth embodiment;

FIG. 19A is a plane view for explaining an IC mounting step of the wireless tag according to the fifteenth embodiment;

FIG. 19B is a side view for explaining the IC mounting step of the wireless tag according to the fifteenth embodiment;

FIG. 20A is a plane view for explaining an integrating step of the wireless tag according to the fifteenth embodiment;

FIG. 20B is a side view for explaining the integrating step of the wireless tag according to the fifteenth embodiment;

FIG. 21A is a plane view for explaining a dielectric member injecting step of the wireless tag according to the fifteenth embodiment;

FIG. 21B is a sectional view of a side face for explaining the dielectric member injecting step of the wireless tag according to the fifteenth embodiment;

FIG. 21C is a plane view of a rear face for explaining the dielectric member injecting step of the wireless tag according to the fifteenth embodiment;

FIG. 22A is a plane view of a wireless tag according to a sixteenth embodiment;

FIG. 22B is a sectional view of a side face of the wireless tag according to the sixteenth embodiment;

FIG. 22C is a plane view of a rear face of the wireless tag according to the sixteenth embodiment;

FIG. 23 shows conductor formation and an IC mounting step of a wireless tag according to a seventeenth embodiment;

FIG. 24A is a plane view for explaining integration and constitution of the wireless tag according to the seventeenth embodiment;

FIG. 24B is a side view for explaining integration and constitution of the wireless tag according to the seventeenth embodiment;

FIG. 25A is a plane view of a wireless tag according to an eighteenth embodiment;

FIG. 25B is a side view of the wireless tag according to the eighteenth embodiment;

FIG. 26A is a plane view of a wireless tag according to a nineteenth embodiment;

FIG. 26B is a side view of the wireless tag according to the nineteenth embodiment;

FIG. 27A is a plane view for explaining integration of a wireless tag conductor and IC mounting according to a twentieth embodiment;

FIG. 27B is a plane view for explaining the integration of the wireless tag conductor and the IC mounting according to the twentieth embodiment;

FIG. 27C is a side view for explaining the integration of the wireless tag conductor and the IC mounting according to the twentieth embodiment;

FIG. 28A is a plane view of a wireless tag according to a twenty-first embodiment;

FIG. 28B is a side view of the wireless tag according to the twenty-first embodiment;

FIG. 29A is a plane view of a conductor of an antenna for the wireless tag according to a twenty-second embodiment;

FIG. 29B is a side view of the conductor of the antenna for the wireless tag according to the twenty-second embodiment;

FIG. 30A is a plane view for explaining a step of mounting IC for the wireless tag according to the twenty-second embodiment;

FIG. 30B is a side view for explaining the step of mounting IC for the wireless tag according to the twenty-second embodiment;

FIG. 31A is a plane view for the wireless tag according to the twenty-second embodiment;

FIG. 31B is a side view of a section for the wireless tag according to the twenty-second embodiment;

FIG. 32A is a plane view of a quarter-wavelength antenna for a wireless tag according to a twenty-third embodiment;

FIG. 32B is a side view of the quarter-wavelength antenna for the wireless tag according to the twenty-third embodiment;

FIG. 32C is a plane view of a rear face of the quarter-wavelength antenna for the wireless tag according to the twenty-third embodiment;

FIG. 33A is a plane view of a quarter-wavelength antenna for a wireless tag according to a twenty-fourth embodiment;

FIG. 33B is a side view of the quarter-wavelength antenna for the wireless tag according to the twenty-fourth embodiment;

FIG. 33C is a plane view of a rear face of the quarter-wavelength antenna for the wireless tag according to the twenty-fourth embodiment;

FIG. 34A is a plane view of a quarter-wavelength antenna for a wireless tag according to a twenty-fifth embodiment;

FIG. 34B is a side view of the quarter-wavelength antenna for the wireless tag according to the twenty-fifth embodiment;

FIG. 34C is a plane view of a rear face of the quarter-wavelength antenna for the wireless tag according to the twenty-fifth embodiment;

FIG. 35A is a plane view of a quarter-wavelength antenna for a wireless tag according to a twenty-sixth embodiment;

FIG. 35B is a side view of the quarter-wavelength antenna for the wireless tag according to the twenty-sixth embodiment;

FIG. 35C is a plane view of a rear face of the quarter-wavelength antenna for the wireless tag according to the twenty-sixth embodiment;

FIG. 36A is a plane view of a quarter-wavelength antenna for a wireless tag according to a twenty-seventh embodiment;

FIG. 36B is a side view of the quarter-wavelength antenna for the wireless tag according to the twenty-seventh embodiment;

FIG. 36C is a plane view of a rear face of the quarter-wavelength antenna for the wireless tag according to the twenty-seventh embodiment;

FIG. 37A is a plane view of a conductor of a quarter wavelength type wireless tag according to a twenty-eighth embodiment;

FIG. 37B is a side view of the conductor of the quarter wavelength type wireless tag according to the twenty-eighth embodiment;

FIG. 38A is a plane view for explaining an IC mounting step of the quarter wavelength type wireless tag according to the twenty-eighth embodiment;

FIG. 38B is a side view for explaining the IC mounting step of the quarter wavelength type wireless tag according to the twenty-eighth embodiment;

FIG. 39A is a plane view of the quarter wavelength type wireless tag according to the twenty-eighth embodiment;

FIG. 39B is a side view of the quarter wavelength type wireless tag according to the twenty-eighth embodiment;

FIG. 39C is a plane view of a rear face of the quarter wavelength type wireless tag according to the twenty eighth embodiment;

FIG. 40A is a plane view for explaining a conductor and IC of a quarter wavelength type wireless tag according to a twenty-ninth embodiment;

FIG. 40B is a side view for explaining the conductor and the IC of the quarter wavelength type wireless tag according to the twenty ninth embodiment;

FIG. 41 is a constitution diagram for explaining a constant voltage forming system of a wireless tag according to a thirteenth embodiment;

FIG. 42 is a constitution diagram for explaining a constant voltage forming system of a wireless tag according to a thirty-first embodiment;

FIG. 43 is a constitution diagram for explaining a light emitting signal generating system of a wireless tag according to a thirty-second embodiment;

FIG. 44 is a constitution diagram for explaining an IC constitution of a wireless tag according to a thirty-third embodiment;

FIG. 45A is a plane view of a constant voltage type/light emitting type wireless tag according to a thirty-fourth embodiment;

FIG. 45B is a side view of the constant voltage type/light emitting type wireless tag according to the thirty-fourth embodiment;

FIG. 46A is a plane view of a constant voltage type/light emitting type wireless tag according to a thirty-fifth embodiment;

FIG. 46B is a side view of the constant voltage type/light emitting type wireless tag according to the thirty-fifth embodiment;

FIG. 47A is a plane view of an LED mounting structure of the constant voltage type/light emitting type wireless tag according to the thirty-fifth embodiment; and

FIG. 47B is a side view of the LED mounting structure of the constant voltage type/light emitting type wireless tag according to the thirty-fifth embodiment.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] FIGS. 3A, 3B, 3C are view showing a constitution of a half wavelength type antenna constituted by a microstrip-line showing a first embodiment of the present invention in which FIG. 3A is a plane view of a surface thereof, FIG. 3B is a sectional view of a side place thereof and FIG. 3C is a plane view of a rear face thereof. In FIGS. 3A, 3B, 3C, numeral 13 designates an antenna conductor, numeral 14 designates a dielectric member, numeral 15 designates an earth conductor, numeral 16 designates a feed point, numeral 17 designates an input/output terminal of signal and numeral 18 designates a through hole.

[0015] In FIGS. 3A, 3B, 3C, a length "ℓ" of the antenna conductor 13 is set to a length in correspondence with a half wavelength in an operational frequency. A width "w" of the antenna conductor 13 is a parameter for setting the radiation efficiency of the antenna. The through hole 18 corresponds with substantially a middle point of the antenna conductor 13 and is electrically connected to the earth conductor at the rear face. A rectifying circuit portion of the rectenna is connected to the signal input/output terminal 17 and a signal is inputted to the antenna conductor 13 from the feed point.

[0016] FIG. 4 shows an equivalent circuit of the antenna shown by FIGS. 3A, 3B, 3C. In FIG. 4, an element having operation the same as that in the plane view of FIG. 3A is attached with the same numeral and an explanation thereof will be omitted. Length portions on the left and on the right of the through hole 18 at the middle point of the half wavelength type antenna conductor 13 respectively constitute resonators each having a length of a quarter wavelength and respectively represented by resonators comprising parallel circuits of an inductor L1, a condenser C1 and a resistor R1 as well as an inductor L2, a condenser C2 and a resistor R2. The resonator on the right side is connected to the resonator on the left side via an inductor L3 and is grounded via an inductor M1. The resonator on the right side is connected with the rectifying circuit portion of the rectenna at a signal input/output terminal 17a with a point of connecting the parallel resonating circuit and the inductor L3 as a feed point 16a. The circuit of FIG. 4 constitutes a double tuned circuit in which the left and right resonating circuits are coupled by the inductor M1. According to the double tuned circuit, it is known that in comparison with a single tuned circuit, the matching frequency band is widened and there will be constructed a constitution of an optimized resonant circuit absorbing a dispersion of a manufacturing dispersion or the like and suitable for a case of ensuring a function thereof and a case in which a using frequency band is wide.

[0017] FIGS. 5A, 5B and 5C are constitution views of an antenna comprising a microstrip-line showing a second embodiment of the present invention in which FIG. 5A is a plane view, FIG. 5B is a sectional view of a side face along a line A-A of FIG. 5A and FIG. 5C is a plane view of rear face thereof. In FIGS. 5A, 5B and 5C, numeral 19 designates an antenna conductor, numeral 20 designates a dielectric member, numeral 21 designates an earth conductor, numeral 22 designates a through hole, numeral 23 designates a feed point and numeral 24 designates a signal input/output terminal. A point of the embodiment which is different from the first embodiment in view of the constitution resides in that in the feed point 23 and the signal input/output terminal 24, the signal input/output terminal 24 is formed on the rear face of the dielectric member plate 20 by using a through hole. The rectifying circuit portion of the rectenna circuit can be arranged on the side of the earth conductor plate of the rear face. With regard to the width "w" and the length "ℓ" of the antenna conductor 19, these are operated similar to those in FIGS. 3A, 3B and 3C.

[0018] A plane view of a surface of a half wavelength type antenna shown by FIG. 6 is a drawing showing a third embodiment of the present invention, numeral 25 designates an antenna conductor, numeral 26 designates a dielectric member and numeral 27 designates a through hole. A call signal input/output terminal and a feed line of power feed are omitted. Although omitted in the drawing, an earth conductor plate arranged on a rear face of the dielectric member 26 is constituted by a microstrip-line. By setting distances $\ell 1$ and $\ell 2$ from the through hole 27 connected to the earth conductor of the antenna conductor 25 to open ends to different values, there can be constructed an antenna resonated at two different frequencies. This is effective in the case in which the frequency band is intended to widen and the case of constituting an antenna functioning at two different frequencies in correspondence with a quarter wavelength although the sensitivity of the antenna is more or less reduced. Operation of the width "w" of the antenna conductor 25 here is similar to those in the previous examples.

[0019] FIG. 7 is a plane view of a surface of a half wavelength type antenna having a microstrip constitution showing a fourth embodiment of the present invention. In Fig. 7, numeral 28 designates a first quarter-wavelength resonator, numeral 29 designates a second quarter-wavelength resonator, numeral 30 designates a dielectric member and numeral 31 designates a through hole. A feed point, an input/output terminal of signal and a feed line are omitted. A point of the embodiment different from the third embodiment of FIG. 6 resides in constituting the resonator constituting the antenna by the through hole 31 connected to an earth conductor at a rear face omitted in the drawing, by the first quarter-wavelength resonator 28 and the second quarter-wavelength resonator 29 and in that lengths of lines of the first quarter-wavelength resonator and the second quarter-wavelength resonator are respectively different from ℓ1, ℓ2 and w1, w2. Thereby, there can be realized simultaneously two antennas respectively having different Q values and frequencies of quarter-wavelength resonators.

[0020] FIGS. 8A, 8B and 8C are drawings of a half wavelength type antenna having a microstrip constitution showing a fifth embodiment in which FIG. 8A is a plane view of an antenna face of the antenna, FIGS. 8B and 8C are sectional views of side face thereof. In FIGS. 8A, 8B and 8C, numeral 32 designates an antenna conductor, numeral 33 designates a first dielectric member, numeral 34 designates a through hole, numeral 35 designates a feed point, numeral 36 designates a signal input/output terminal, numerals 37 and 38 designate cavities, numeral 39 designates an earth conductor, numeral 40 designates a second dielectric member and numeral 41 designates a third dielectric member. A point thereof different from FIGS. 3A, 3B and 3C showing the first embodiment resides in forming the cavities 37 and 38 by notching portions of the dielectric member 33 between the antenna conductor 32 and the earth conductor 39 and in replacing portions of the dielectric member plate 39 by the second dielectric member 40 and the third dielectric member 41 having different material. The material of the dielectric member between the antenna pattern 32 and the earth conductor 39 of the antenna having the microstrip-line constitution, is closely related to the frequency and the sensitivity and is effective in changing the antenna characteristic.

[0021] FIGS. 9A, 9B and 9C are drawings showing a half wavelength type antenna having a microstrip-line constitution showing a sixth embodiment of the present invention in which FIG. 9A is a plane view thereof, FIG. 9B is a sectional view of a side face thereof and FIG. 9C is a plane view of a rear face thereof. In FIGS. 9A, 9B and 9C, numeral 45 designates an antenna conductor, numeral 46 designates an earth conductor, numeral 47 designates a dielectric member, numeral 48 designates a through hole, numeral 49 designates a feed point and numeral 50 designates a signal input/output terminal. A point of the embodiment different from the embodiment of FIGS. 5A, 5B and 5C resides in arranging the dielectric member 47 only between the antenna pattern 45 and the earth conductor 50.

[0022] FIGS. 10A and 10B are drawings showing a wireless tag having a half wavelength type antenna having a microstrip-line constitution showing a seventh embodiment of the present invention in which FIG. 10A is a plane view thereof, and FIG. 10B is a sectional view of a side face thereof. Numeral 51 designates an antenna conductor, numeral 52 designates an earth conductor, numeral 53 designates a dielectric member, numeral 54 designates a through hole, numeral 55 designates an earth point, numeral 56 designates a feed point and numeral 57 designates a circuit portion. The feed point 56 constituting a signal input/output portion of a rectenna circuit for rectifying current, supplying power to a circuit portion of the wireless tag and modulating and demodulating signals inputted to or outputted from the circuit portion 57, is provided at a point on a side of an open end of the antenna conductor 51 remote from the through hole 54 constituting an electric earth point of the antenna conductor 51 and the earth point 55 is provided to be proximate to the through hole. According to the example, the circuit portion 57 is provided on the side of the antenna conductor face.

[0023] FIGS. 11A and 11B are drawings of a wireless tag constituted by a half wavelength-antenna comprising a microstrip-line and a circuit portion showing an eighth embodiment of the present invention. FIG. 11A is a plane view thereof and FIG. 11B is a sectional view of a side face thereof. In FIGS. 11A and 11B, numeral 58 designates an antenna conductor, numeral 59 designates a dielectric member, numeral 60 designates an earth conductor, numeral 61 designates a through hole, numeral 62 designates an atmospherics-line, numeral 63 designates a signal input/output terminal, numeral 64 designates an earth point and numeral 65 designates a circuit portion. A point of the embodiment different from FIGS. 10A and 10B showing the seventh embodiment resides in that the signal input/output terminal 63 is provided on the dielectric member substrate plate 59 and connected to the circuit portion via a feed point on a side of the antenna conductor 58 via the feed line 62. Even in the case in which the feed point is remote from a region occupied by the circuit portion 65, circuit connection can easily be carried out by prolonging the feed line.

[0024] FIGS. 12A and 12B are drawings showing a half wavelength type wireless tag comprising a microstrip-line showing a ninth embodiment of the present invention in which FIG. 12A is a plane view thereof and FIG. 12B is a sectional view of a side face thereof. In FIGS. 12A and 12B, numeral 66 designates an antenna conductor, numeral 67 designates a dielectric member, numeral 68 designates an earth conductor, numeral 69 designates a through hole, numeral 70 designates an earth point, numeral 71 designates a feed point and numeral 72 designates a circuit portion. A point of the embodiment different from the embodiment of FIGS. 10A and 10B resides in that the earth point 70 and the feed point 71 are provided at the rear face of the antenna conductor 66 and the circuit portion 72 is formed at a removed portion of the dielectric member 67 between the antenna conductor 66 and the earth conductor 68.

[0025] FIGS. 13A and 13B are drawings of a half wavelength type wireless tag constituted by a microstrip-line showing a tenth embodiment of the present invention in which FIG. 13A shows a plane view thereof and FIG. 13B shows a sectional view of a side face thereof, numeral 73 designates an antenna conductor, numeral 74 designates a dielectric member plate, numeral 75 designates an earth conductor plate, numeral 76 designates a through hole, numeral 77 designates a feed line, numeral 78 designates a signal input/output terminal, numeral 79 designates an earth point and numeral 80 designates a circuit portion. A point of the embodiment different from the embodiment of FIG. 11 resides in forming the wireless tag by providing the circuit portion 80 in the dielectric member substrate 74 or embedding the circuit portion therein.

[0026] The reason of providing the circuit portion constituting the wireless tag in each of the embodiments of FIGS. 10A and 10B, FIGS. 11A and 11B, FIGS. 12A and 12B and FIGS. 13A and 13B resides in reducing as less as possible a potential difference between the earth point of the circuit portion and the earth point of the antenna (through hole), suppressing noise interference and improving matching performance between the circuit portion and the antenna at high frequencies.

[0027] FIGS. 14A, 14B and 14C are drawings showing a wireless tag constituted by a microstrip-line showing an eleventh embodiment of the present invention in which FIG. 14a is a plane view of a half wavelength type antenna thereof and FIG. 14B is a sectional view of a side face thereof and FIG. 14C is a plane view of a rear face thereof. In FIGS. 14A, 14B and 14C, numeral 81 designates an antenna conductor, numeral 82 designates a dielectric member, numeral 83 designates an earth conductor, numeral 84 designates a through hole, numeral 85 designates a feed point and numeral 86 designates a signal input/output terminal. A point of the embodiment different from the embodiment of FIGS. 5A, 5B and 5C resides in that in FIGS. 5A, 5B and 5C, while the earth conductor plate is formed in a plate-like shape and is restricted by the size of the dielectric member, in FIGS. 14A, 14B and 14C, the earth conductor 83 covers end faces of the dielectric member 82 and the earth point is extended up to the face of the dielectric member relative to the antenna conductor 81. When the plate thickness of the dielectric member plate 82 is thin, the earth conductor covering the end face portions do not have an influence of changing the earth point of the antenna, however, when the plate thickness of the dielectric member plate 82 is thickened, in the case in which the wireless tags are arranged to be proximate to each other, there is achieved an effect of improving a drawback of changing an impedance between the wireless tags at high frequencies to thereby change the radiation characteristic of the antenna.

[0028] FIGS. 15A, 15B and 15C are drawings showing a half wavelength type antenna of a wireless tag having a microstrip-line constitution according to a twelfth embodiment of the present invention in which FIG. 15A is a plane view thereof, FIG. 15B is a sectional view of a side face thereof and FIG. 15C is a plane view of a rear face thereof. In FIGS. 15A, 15B and 15C, numeral 87 designates an antenna conductor, numeral 88 designates a dielectric member, numeral 89 designates an earth conductor, numeral 90 designates a through hole, numeral 91 designates a feed point, numeral 92 designates a signal input/output terminal and numerals 93 and 94 designate earth lines. A point of the embodiment different from the eleventh embodiment of FIGS. 14A, 14B and 14C resides in providing the earth lines 93 and 94 between positions of substantially middle points of the antenna conductor and the earth conductor 89, achieving an effect of further reducing the impedance relative to the earth impedance of the through hole 90 and achieving an effect of narrowing a matching frequency band by double-tuning of antennas of the antenna conductor 87 in correspondence with a quarter wavelength.

[0029] FIGS. 16A, 16B and 16C are drawings showing a half wavelength type antenna for a wireless tag constituted by a microstrip-line showing a thirteenth embodiment of the present invention in which FIG. 16A is a plane view thereof, FIG. 16B is a sectional view of a side face thereof and FIG. 16C is a plane view of a rear face thereof. In FIGS. 16A, 16B and 16C, numeral 93 designates an antenna conductor, numeral 94 designates a dielectric member, numeral 95 designates an earth conductor, numeral 96 designates a feed point, numerals 97 and 98 designate earth lines and numeral 99 designates a signal input/output terminal. A point of the embodiment different from FIGS. 15A, 15B and 15C resides in that the antenna conductor 93 is not provided with a through hole at its central portion and is electrically and mechanically connected to the earth conductor by the earth lines 97 and 98. The magnitude of the inductor M1 indicated by the equivalent circuit of FIG. 4 can be changed by connecting thereto by the earth lines 97 and 98 with widths and lengths of the earth lines as parameters, therefore, the matching frequency band at high frequencies by double-tuning can freely be set.

[0030] FIGS. 17A, 17B and 17C are drawings showing a wireless tag constituted by a microstrip-line showing a fourteenth embodiment of the present invention in which FIGS. 17A is a plane view thereof, FIG. 17B is a sectional view of a side face thereof and FIG. 17C is a plane view of a rear face thereof. In FIGS. 17A, 17B and 17C, numeral 100 designates an antenna conductor, numeral 101 designates a dielectric member, numeral 102 designates an earth conductor, numerals 103 and 104 designate earth lines, numeral 105 designates a feed line and numeral 106 designates IC and numerals 107 and 108 designate holes. A circuit of the wireless tag including a rectifying circuit of a rectenna is constituted by IC formation to thereby form IC 106 by technologies of wire bonding and the like, the circuit is embedded in a dielectric member material on an earth conductor side by a rear face of the earth line 104 connected to the central portion of the antenna conductor 100, an earth portion of IC 106 is grounded and at the same time, an input/output portion of IC 106 is connected to a face on a side of the earth conductor of the feed line 105. The holes 107 and 108 provided at the antenna 100 improve a performance of adhering the dielectric member material and the antenna conductor to thereby prevent the antenna conductor 100 from floating up from the dielectric member 101.

[0031] FIGS. 18A and 18B show mounting of a wireless tag and its structure showing a fifteenth embodiment of the present invention. An antenna portion of the wireless tag having a microstrip-line constitution is manufactured to shape as shown by the plane view of FIG. 18A and the side view of FIG. 18B by pressing a thin plate member of copper, copper alloy or iron alloy for a lead frame in an IC mounting technology of transfermold or the like. In FIGS. 18A and 18B, numeral 115 designates an earth conductor, numeral 116 designates an antenna conductor, numeral 117 designates a feed line, numerals 118 and 119 designate earth lines and numeral 120 designates a fitting portion. The antenna conductor 116, the earth lines 118 and 119, the feed line 117 and the earth conductor 115 are integrally shaped. FIGS. 19A and 19B are drawings for explaining a next stage of mounting operation according to the embodiment of the present invention in which FIG. 19A is a plane view thereof and FIG. 19 is a side view thereof and an element operating similar to that in FIGS. 18A and 18B is attached with the same numeral. In FIGS. 19A and 19B, numeral 121 designates IC and numerals 122 and 123 designate bonding wires. An earth portion of IC 121 fixed to a side of the earth line 118 of the antenna conductor 116 by an adhering agent, is electrically connected to a surface side of the earth line 118 by the bonding wire 122. At the same time, a signal input/output portion of IC 121 is electrically connected to an open end of the feed line 118 by bonding wire 123. At this occasion, in an IC constitution in which an earth face can be formed on a side opposed to a face formed with a connecting pad of IC 121, the bonding wire 122 is dispensed with and attachment of IC 121 to the antenna conductor 116 or the earth line 118 may be carried out electrically and mechanically by a conductive adhering agent. FIGS. 20A and 20B are drawings for explaining a next step for mounting according to the embodiment of the present invention in which FIG. 20A is a plane view thereof and FIG. 20B is a side view thereof. In FIGS. 20A and 20B, an element operated similar to that in FIGS. 18A and 18B is attached with the same numeral. In reference to the plane view of FIG. 20A, the earth line 118 in FIGS. 19A and 19B is folded at a portion thereof connected to the ground conductor 115 and is arranged in a state of a lid at an opening portion of the earth conductor 115 in a box-like shape. At this occasion, an open end of the earth line 119 is fitted to the fitting portion of the earth conductor 115 by press fitting, welding, soldering or the like and is electrically and mechanically connected thereto. Under the state, the dielectric member is constituted by air and accordingly, according to the embodiment having the microstrip-line constitution, shortening of wavelength is not carried out and a length in the longitudinal direction of the wireless tag is prolonged. Further, the dielectric member is air and accordingly, there is needed a structure in which the antenna conductor 116 is mechanically supported by auxiliary using a material having a small specific inductive capacity such as a foaming agent. FIGS. 21A, 21B and 21C are drawings showing a final step of the steps according to the embodiment in which FIG. 21A is a plane view thereof, FIG. 21B is a sectional view of a side face taken along a line A-A in FIG. 21A and FIG. 21C is a plane view of a rear face thereof, an element operated similar to that in FIGS. 18A and 18B, FIGS. 19A and 19B and FIGS. 20A and 20B is attached with the same numeral. In FIGS. 21A, 21B and 21C, numeral 124 designates a dielectric member. By injecting a molding material for transfermold into a cabinet formed by the earth conductor 115 and the antenna conductor 116 underthe state of FIGS. 20A and 20B, IC 121 and the bonding wires 122 and 123 around IC 121 are mechanically fixed and protection of IC 121 and the bonding wires 122 and 123 is achieved by preventing moisture caused by the humidity from invading from outside.

[0032] FIGS. 22A, 22B and 22C are drawings showing a sixteenth embodiment in mounting a wireless tag having a microstrip-line structure in which FIG. 22A is a plane view thereof, FIG. 22B is a sectional view of a side face taken along a line A-A of FIG. 22A and FIG. 22C is a plane view of a rear face thereof. An element operated similar to that in FIGS. 21A, 21B and 21C are attached with the same numeral. In FIGS. 22A, 22B and 22C, numeral 125 designates a dielectric member. According to the embodiment, by constructing a structure in which the dielectric member 125 covers to embed the antenna conductor 116, invasion of the humidity invading from a clearance between the antenna conductor 116 and the dielectric member 124 of FIGS. 21A, 21B and 21C can effectively be prevented.

[0033] FIG. 23 is a plane view of a structure of mounting a wireless tag having a microstrip-line constitution showing a seventeenth embodiment of the present invention. In FIG. 23, numeral 126 designates an earth conductor, numeral 127 designates an antenna conductor, numerals 128 and 129 designate earth lines, numeral 130 designates a feed line, numeral 131 designates IC, numerals 132, 133 and 134 designate folding lines of valley folding and numerals 135 and 136 designate bonding wires. All elements except IC

131 and the bonding wires 135 and 136 are constituted on a thin plate made of a single sheet of copper, copper alloy or iron alloy. IC 131 is fixed at a location at a vicinity of a point of connecting the antenna conductor 127 and the earth line 129 of the thin plate having low electrical potential by an adhering agent or a conductive adhering agent and connected to a point having lower potential on the earth line by the bonding wire 135 and a signal input/output portion of IC 131 is connected to an open end of a feed line by the bonding wire 136 to thereby input a signal received from the antenna to IC 131 or transmits a signal from IC 131 of the antenna. By folding in valley folding of the valley folding lines 132, 133 and 134, a wireless tag having a microstrip-line constitution is formed as shown by FIGS. 24A and 24B. FIG. 24A is a plane view of a wireless tag and FIG. 24B is a side view thereof. An element operated similar to that in FIG. 23 is attached with the same numeral. The antenna having the rnicrostrip-line constitution according to the embodiment is provided with a structure having no dielectric member and arranged in air.

[0034] FIGS. 25A and 25B are drawings showing a wireless tag having a microstrip-line constitution showing an eighteenth embodiment of the present invention, FIG. 25A is a plane view thereof, FIG. 25B is a side view thereof and an element operated similar to that in FIGS. 24A and 24B is attached with the same numeral. In FIGS. 25A and 25B, numerals 137 and 138 designate dielectric member supporters. According to the embodiment, there is constructed a structure in which the antenna conductor 127 arranged in air of FIG. 24 is held by the dielectric member supporters formed by the dielectric member, in consideration of increasing mechanical strength of the antenna conductor 127 and stably operating as the antenna of the wireless tag.

[0035] FIGS. 26A and 26B are drawings showing a nineteenth embodiment of the present invention and an element operated similar to FIGS. 24A and 24B is attached with the same numeral. In FIGS. 26A and 26B, notations 139 and 139a designate dielectric members. A point of the embodiment different from the embodiment of FIGS. 24A and 24B resides in interposing the dielectric members 139 and 139a between the antenna conductor 127 and the earth conductor 126. The dielectric members 139 and 139a achieve high effect as the dielectric members such as shortening of wavelength at vicinities of open ends of the antenna. When an expensive dielectric member is utilized, such a means is effective.

[0036] FIGS. 27A, 27B and 27C are drawings showing a wireless tag having a microstrip-line constitution showing a twentieth embodiment of the present invention. FIGS. 27A is a plane view of an earth conductor plate, FIG. 27B is a plane view showing a situation of mounting IC with an antenna conductive plate as a main constituent element and FIG. 27C is a side view of a wireless IC tag integrated with constituent elements of FIG. 27A and FIG. 27B.

[0037] In FIGS. 27A, 27B and 27C, numeral 140 designates an earth conductor plate, numeral 141 designates an antenna conductor, numerals 142 and 143 designate earth lines, numerals 145 and 146 designate folding lines of valley folding, numeral 147 designates a feed line, numeral 148 designates IC, numerals 149 and 150 designate bonding wires, numerals 151 and 152 designate open ends of earth lines and numerals 153 and 154 designate fitting portions. The earth lines 142 and 143 continuous to the antenna conductor 141 of FIG. 27B are folded to bend at the folding lines 145 and 146, the open ends 151 and 152 are fitted to the fitting portions 154 and 153 of the earth plate and mechanically and electrically connected thereto by a method of press fitting, welding, soldering or the like to thereby provide the wireless tag of the side face as shown by FIG. 27C. According to the wireless tag of the embodiment, there is adopted the microstrip-line constitution constituting air as a dielectric member.

[0038] FIGS. 28A and 28B show a twenty-first embodiment of a wireless tag having a microstrip-line constitution according to the present invention. FIG. 28A is a plane view thereof and FIG. 28B is a side view thereof. In FIGS. 28A and 28B, an element operated similar to that in FIGS. 27A, 27B and 27C is attached with the same numeral. In FIGS. 28A and 28B, numeral 155 designates a dielectric member. A point of the embodiment different from the embodiment of FIGS. 27A, 27B and 27C resides in enveloping a total of the wireless tag by the dielectric member. Naturally, the dielectric member 155 is uniformly filled between the earth conductor 140 and the antenna conductor 141.

[0039] FIGS. 29A and 29B are drawings showing a twenty-second embodiment of the present invention, FIG. 29A is a plane view showing a structure of mounting a wireless tag comprising an antenna using a microstrip-line and FIG. 29B is a side view thereof. In FIGS. 29A and 29B, numeral 156 designates an earth conductor formed in a shape of a box one face of which is brought into an opened state, numerals 157 and 158 designate fitting portions, numerals 159 and 160 designate earth lines, numeral 161 designates a feed line and numeral 162 designates an antenna conductor. A point of the embodiment different from the fifteenth embodiment resides in that conductor portions formed by thin plates of copper, copper alloy or iron alloy comprising the antenna conductor 162, the earth lines 159 and 160 and the feed line 161 are formed by pieces separate from the earth conductor 156. FIGS. 30A and 30B are drawings showing a mounting step successive to the mounting step shown by FIGS. 27A and 27B of the wireless tag constituted by the microstrip-line, FIG. 30A is a plane view thereof and FIG. 30B is a side view thereof. An element operated similar to that in FIGS. 29A and 29B is attached with the same numeral. In FIGS. 30A and 30B, numeral 163 designates IC and numerals 164 and 165 designate bonding wires. IC 163 of the wireless tag is mechanically or mechanically and electrically connected to fixed to a portion of connecting the antenna conductor 162 and the earth line 159 by an adhering agent or a conductive adhering agent and connected thereto at a position as proximate as possible to a portion of fitting to the earth conductor 156 on the earth line 159 to ground IC 163 by the bonding wire 164. A signal input/output portion of IC is connected to an open end portion of the feed line 161 by the bonding wire 165. A constitution showing amounting operation of a successive stage is shown by a plane view of FIG. 31A and FIG. 31B constituting a side view of a section taken along a line A-A of FIG. 31A. In FIGS. 31A and 31B, an element operated similar to that in FIGS. 30A and 30B is attached with the same numeral. In reference to the plane view of FIG. 31A, the antenna conductor 162 mounted with IC 163 of FIGS. 30A and 30B is turned upside down and open ends of the earth lines 158 and 159 and the fitting portions 158 and 157 are electrically and mechanically connected by press fitting, welding, soldering or the like. As a result, the antenna conductor 162 arranged with IC 163 and the bonding wires 164 and 165 is attached to an opening portion of the ground conductor 156 such that IC 163 is arranged on the inner side of the cabinet. The dielectric member is air. An unstable structure is constituted by holding the antenna conductor 162 in a cantilever state and accordingly, mechanical strength and electrical stability are maintained by feeding a resin of a foaming agent near to air or introducing supporters comprising a dielectric member as shown by FIGS. 25A and 25B and FIGS. 26A and 26B. Protection of IC 163 and the bonding wires 164 and 165 are separately needed. By filling a resin mold material by transfermold or resin filling to a cavity portion of the wireless tag of FIGS. 31A and 31B, a downsized wireless tag can be realized by the effect of wavelength shortening and at the same time, IC 163 or the bonding wires 164 and 165 can be protected.

[0040] FIGS. 32A, 32B and 32C are drawings showing an antenna of a wireless tag showing a twenty-third embodiment of the present invention in which FIG. 32A is a plane view thereof, FIG. 32B is a side view showing a section taken along a line A-A of FIG. 32A and FIG. 32C is a plane view of a rear face thereof. In FIGS. 32A, 32B and 32C, numeral 166 designates an antenna conductor, numeral 167 designates a dielectric member, numeral 168 designates a through hole, numeral 169 designates a feed point, numeral 170 designates an input/output terminal of signal and numeral 171 designates an earth conductor. A quarter wavelength type antenna conductor 166 operates as an antenna constituted by a quarter wavelength type microstrip-line opening multiple ends one end of which is grounded to the earth conductor 171 of the rear face by the through hole 168. The antenna 166 constitutes a microstrip-line constituted by the dielectric member and the earth conductor 171. The feed point 169 is connected to the signal input/output terminal of the rear face via the through hole. The signal input/output terminal is connected with IC including a rectenna circuit. The antenna conductor 166 is provided with a length "ℓ" having a length in correspondence with substantially a quarter wavelength and is resonated at a corresponding frequency. A width "w" of the antenna conductor 166 is determined in consideration of the efficiency of the antenna and matching with the IC circuit.

[0041] FIGS. 33A, 33B and 33C are drawings showing an antenna of a quarter wavelength microstrip-line type showing a twenty-fourth embodiment of the present invention in which FIG. 33A is a plane view thereof, FIG. 33B is a side view showing a section taken along a line A-A of FIG. 33A and FIG. 33C is a plane view of a rear face thereof. In FIGS. 33A, 33B and 33C, numeral 172 designates an antenna conductor, numeral 173 designates a dielectric member, numeral 174 designates an earth conductor, numeral 175 designates an earth line, numeral 176 designates a feed point and numeral 177 designates a signal input/output terminal. A point of the embodiment different from the embodiment of FIGS. 32A, 32B and 32C resides in that an earth side of the antenna conductor 172 is electrically connected to the earth conductor 174 of the rear face by the earth line 175.

[0042] FIGS. 34A, 34B and 34C show a twenty-fifth embodiment of the present invention and concerns a constitution in which a portion of the dielectric member in FIGS. 33A, 33B and 33C is replaced by other dielectric member and other dielectric member having a pertinent material can be selected in accordance with a resonance frequency of the antenna, a matching state and price of the dielectric member material. In FIGS. 34A, 34B and 34C, numeral 178 designates an antenna conductor, numeral 179 designates a dielectric member, numeral 180 designates an earth conductor, numeral 181 designates a feed point, numeral 182 designates an earth line and numeral 183 designates a signal input/output terminal. IC of a wireless tag can be connected to the rear face via a signal input/output terminal of the rear face.

[0043] FIGS. 35A, 35B and 35C are drawings showing a quarter-wavelength antenna for a wireless tag by a microstrip-line showing a twenty-sixth embodiment of the present invention. FIG. 35A is a plane view thereof, FIG. 35B is a side view showing a section taken along a line A-A of FIG. 35A and FIG. 35C is a plane view of a rear face thereof. In FIGS. 35A, 35B and 35C, numeral 185 designates an antenna conductor, numeral 186 designates a dielectric member, numeral 187 designates an earth conductor, numeral 188 designates an earth line, numeral 189 designates a feed point and numeral 190 designates a signal input/output terminal. A point of the embodiment different from the embodiment of FIGS. 34A, 34B and 34C resides in that the earth conductor 187 covers end faces of the dielectric member 186. With regard to covering of the earth conductor 187 up to the end faces of the conductor, as described in the example of the antenna of the half wavelength type in the example of FIGS. 14A, 14B and 14C, when the plate thickness of the dielectric member 187 is thin, the earth conductor covering the end face portions does not effect influence of changing the earth point of the antenna, however, when the plate thickness of the dielectric member 187 is thick, in the case in which the wireless tags are arranged to be proximate to each other, there is achieved an effect of improving against a change in the radiation characteristic of the antenna by changing the impedance between the wireless tags at high frequencies.

[0044] FIGS. 36A, 36B and 36C show a twenty-seventh embodiment of the present invention, showing a constitution of a quarter-wavelength antenna having a microstrip-line constitution. FIG. 36A is a plane view thereof, FIG. 36B is a side view showing a section taken along a line A-A of FIG. 36A and FIG. 36C is a plane view of a rear face thereof. In FIGS. 36A, 36B and 36C, numeral 191 designates an antenna conductor, numeral 192 designates an earth conductor, numeral 193 designates an earth line, numeral 194 designates a feed point, numeral 195 designates a signal input/output terminal and numeral 196 designates a dielectric member. A point of the embodiment different from the embodiment of FIGS. 35A, 35B and 35C resides in that the dielectric member 196 is arranged to restrict to only between the lower side of the antenna conductor and the earth conductor. This is a constitution effective in the case in which an expensive material is introduced as the material of the dielectric member 196.

[0045] FIGS. 37A, 37B, FIGS. 38A, 38B, FIGS. 39A, 39B, 39C are drawings of a twenty-eighth embodiment of the present invention showing a method of mounting a wireless tag using a quarter wavelength type antenna utilizing a microstrip-line. First, FIGS. 37A and 37B are drawings showing a behavior of integrally forming an antenna conductor and an earth conductor for mounting IC of a wireless tag by pressing thin plates of copper, copper alloy or iron alloy in which FIG. 37A is a plane view thereof and FIG. 37B is a side view thereof. In FIGS. 37A and 37B, numeral 196 designates an earth conductor, numeral 197 designates an antenna conductor, numerals 198 and 199 designate earth lines, numeral 200 designates a feed line, numeral 201 designates a valley-folding portion and numeral 202 designates a fitting portion. The earth conductor 196 forms a cabinet one face of which is opened and which is provided with a space for filling the dielectric member. One end of the antenna conductor 197 on a side opposed to an open end thereof and portions of the earth lines 198 and 199 in contact with the earth conductor 196, are folded at the valley-folding portion and fitted at the fitting portion 202 at the same time, electrically and mechanically connected thereto by fitting, welding, soldering or the like. A successive step is shown by FIGS. 38A and 38B. FIGS. 38A and 38B show a step of mounting IC for the wireless tag. FIG. 38A is a plane view and FIG. 38B is a sectional view of a side face thereof and an element operated similar to that in FIGS. 37A and 37B is attached with the same numeral. In FIGS. 38A and 38B, numeral 203 designates IC and numerals 204 and 205 designate bonding wires. IC 203 is electrically or mechanically fixed to the antenna conductor by the bonding wires 204 and 205. With regard to an earth point and a signal input portion of IC 203, by the bonding wires 204 and 205, the earth point is connected to a point as proximate as possible to the earth conductor 196 and the signal input/output portion is connected to an open end portion of the feed line 200 to thereby complete a circuit portion of the wireless tag. Next, at a step shown by FIGS. 39A, 39B and 39C, a dielectric member material constituting a dielectric member having a microstrip constitution is filled. FIG. 39A is a plane view after filling a resin mold material by transfermold or mold material injection, FIG. 39B is a side view showing a section taken along a line A-A of FIG. 39A, FIG. 39C is a plane view of a rear face thereof and the dielectric member material is filled from an opening portion of FIGS. 38A and 38B to between the antenna conductor 197 and the earth conductor 196 such that an interval therebetween becomes uniform. An element operated similar to that in FIGS. 38A and 38B is attached with the same numeral. In FIGS. 39A, 39B and 39C, numeral 206 designates the dielectric member.

[0046] FIGS. 40A and 40B show a mounting step of a wireless tag of a quarter wavelength type constituted by a microstrip-line according to a twenty-ninth embodiment of the present invention. FIG. 40A is a plane view thereof and FIG. 40B is a side view thereof. A point of the embodiment different from the embodiment of FIG. 38A and FIG. 38B resides in that an antenna conductor is separated from an earth conductor. In FIGS. 40A and 40B, numeral 207 designates an antenna conductor, notations 208a and 208b designate earth lines, numeral 209 designates an earth conductor, numeral 210 designates a feed line, numeral 211 designates IC and numerals 212 and 213 designate bonding wires. The antenna conductor 207 and the earth conductor 209 can be formed separately and IC 211 can be mounted to the antenna conductor 207 and the manufacturing steps can be constituted by light-weighted formation. Next, the dielectric member is filled by steps the same as the steps shown in FIGS. 39A, 39B and 39C. Or, the antenna conductor 207 in a cantilever constitution is reinforced by using dielectric member supporters in air to thereby mount the wireless tag.

[0047] FIG. 41 shows a block constitution of a wireless tag system showing a thirtieth embodiment of the wireless tag according to the present invention. In FIG. 41, numeral 214 designates an interrogator antenna, numeral 215 designates an input signal, numeral 216 designates an output signal, numeral 217 designates an interrogator, numeral 218 designates a wireless tag, numeral 219 designates an antenna, numeral 220 designates a transmitter and receiver, numeral 221 designates a CMOS logic circuit, numeral 222 designates a memory and numeral 223 designates LED. Upon receiving a signal from the interrogator 217, in the transmitter and receiver, the signal is rectified, power of operating the CMOS logic circuit 221 or the memory 222 is produced, at the same time, a clock signal or a data signal for operating the CMOS logic circuit 221 is generated from the received signal 215 by detection. When a distance between the interrogator antenna 214 and the antenna 219 of the wireless tag is small, there poses a problem in which voltage of a power source formed by the transmitter and the receiver becomes high and exceeds withstand voltage of the CMOS logic circuit or the memory circuit. In order to deal therewith, LED 223 is connected to a power end of the transmitter and receiver 220 in the forward direction such that current flows between LED 223 and the earth. In this case, when LED 223 is applied with voltage of 1.5 through 2 volt or higher, power can be dissipated by a light emitting phenomenon, the CMOS logic circuit 221 or the memory 222 can be prevented from being applied with extra high voltage and at the same time, light can be emitted from LED.

[0048] FIG. 42 is a block diagram of a wireless tag showing a thirty-first embodiment of the present invention. In FIG. 42, an element operated similar to that in FIG. 41 is attached with the same numeral. LED 223 is driven by a signal outputted from the CMOS logic circuit and constituting a modulated signal of the transmitter and receiver. Voltage of substantially power is outputted as output voltage of the CMOS logic circuit and is provided with a capability of driving LED 223. By driving LED 223 by the modulated signal of the CMOS logic circuit, the signal is optically modulated by LED 223 and the signal from the wireless tag can utilize a transmission system using light.

[0049] FIG. 43 is a block diagram showing a thirty-second embodiment of the present invention, numeral 224 designates a wireless tag, numeral 225 designates an antenna, numeral 226 designates a transmitter and receiver, numeral 227 designates a CMOS logic circuit, numeral 228 designates a memory and numeral 229 designates LED. By constituting LED 229 such that light emission thereof is controlled by the signal from the CMOS logic circuit 227, the light emitting phenomenon can be controlled from the interrogator.

[0050] FIG. 44 shows a thirty-third embodiment of the present invention. An element of the embodiment operated similar to that in the embodiment of FIG. 43 is attached with the same numeral. In FIG. 44, numeral 230 designates IC. IC 230 is constituted by a single chip constitution integrated with the transmitter and receiver 226 comprising shottky barrier diodes, the CMOS logic circuit 227, the memory 228 and LED 229.

[0051] FIGS. 45A and 45B are drawings showing a wireless tag of a microwave line constitution showing a thirty-third embodiment of the present invention in which FIG. 45A is a plane view thereof, and FIG. 45B is a side view showing a section taken along a line A-A of FIG. 45A. In FIGS. 45A and 45B, numeral 231 designates an antenna conductor, numeral 232 designates a dielectric member, numeral 233 designates an earth conductor, numeral 234 designates a feed line, numerals 235 and 236 designate earth line, numeral 237 designates IC and numeral 238 designates LED. LED 238 is fabricated by perforating a hole capable of confirming light emission thereof at a central portion in the longitudinal direction and the width direction which is a low potential point of the antenna conductor 231 and is mounted from the rear face of the antenna conductor 231.

[0052] FIGS. 46A and 46B are drawings showing a wireless tag having a microstrip-line constitution showing a thirty-fourth embodiment of the present invention in which FIG. 46A is a plane view thereof and FIG. 46B is a side view of a section taken along a line A-A of FIG. 45A. In FIGS. 46A and 46B, numeral 239 designate an antenna conductor, numeral 240 designates a dielectric member, numeral 241 designates an earth conductor, numerals 242 and 244 designate earth lines, numeral 243 designates a feed line, numeral 245 designates an LED attaching terminal, numeral 246 designates IC and numeral 247 designates LED. The cathode of LED 247 is electrically connected to a point of the antenna conductor 239 in a position proximate to IC 246 of the antenna 239 and the anode is electrically and mechanically connected to the LED attaching terminal 245 having no electric potential. The LED attaching terminal is electrically connected to IC 246 by wirings such as bonding wires for receiving supply of power from IC 246. FIGS. 47A and 47B show a situation of attaching LED 247 in further details.

[0053] FIGS. 47A and 47B show to enlarge a surrounding of LED 247 of the antenna conductor 239 in FIGS. 46A and 46B formed by using thin plates of copper, copper alloy, iron alloy or the like by press forming or the like in which FIG. 47A is a plane view thereof and FIG. 47B is a side view showing a section taken along a line A-A of FIG. 47A. In FIGS. 47A and 47B, numeral 248 designates a frame, numeral 249 designates an earth line, numeral 250 designates an LED attaching terminal, numeral 251 designates a feed line, numeral 252 designates an antenna conductor, numeral 253 designates IC, numeral 254 designates LED, numerals 255 and 256 designate solder and numerals 258 and 259 designate bonding wires. The anode of LED 254 is electrically and mechanically connected to the LED attaching terminal 250 and the cathode of LED is electrically and mechanically connected to the antenna conductor 252 respectively by the solders 256 and 254 and a signal of IC 253 for controlling light emission of LED is supplied by connecting IC 253 and the LED attaching terminal 250 by the bonding wire 259 arranged therebetween. After finishing to attach constituent elements such as LED 254, the antenna conductor 252 and the like and after finishing to fill the dielectric member 240 in FIGS. 46A and 46B, by separating the frame 248 at a broken line portion of B-B in FIGS. 47A and 47B, the

LED attaching terminal 250 constitutes an electrically independent terminal.

[0054] The following can be expected by the wireless tag and the antenna for the wireless tag according to the present invention.

(1) By grounding a middle point of a resonator of a style of a half wavelength type microstrip-line by an impedance element for grounding such as a through hole or a microstrip-line, an antenna constitutes a double tuned circuit comprising quarter wavelength type antennas coupled at high frequencies by the grounding impedance element, and a matching frequency band at high frequencies can be widened more than an antenna of a single resonating mechanism and accordingly, means for avoiding interference from other apparatus used in the same frequency band by switching frequencies transmitted from an interrogator, can easily be introduced without preparing other apparatus in which a frequency band of an antenna of a wireless tag is changed. Further, by changing the magnitude of earth impedance, a frequency band of a matching frequency band at high frequencies can be changed.

(2) With regard to grounding of a middle point of a half wavelength type microstrip-line, by changing widths of lengths of microstrip-lines of respective quarter wavelength type antennas, there can be constituted an antenna resonated by different resonating characteristics at two different frequencies.

(3) There can be adopted a constitution in which a middle point of a half wavelength type antenna is connected to an earth conductor of a microstrip-line by an earth line or a through hole and accordingly, an antenna conductor and an earth conductor can be integrated by connecting and coupling them electrically and mechanically and accordingly, the antenna conductor and the earth conductor can be formed integrally from the same metal plate. Further, despite that the antenna conductor is formed by one sheet of continuous metal plate, at high frequencies, a potential point having a signal potential different from earth potential can be set on a single sheet of the conductor plate. Therefore, IC or a plurality of ICs which need to connect to a plurality of potential points at high frequencies, can easily be mounted to the integrated conductor by means of wire bonding or the like with no need of a complicated shape on the monolithic antenna conductor or the monolithic conductor integral with the antenna conductor and the earth conductor. Therefore, there can be easily introduced packaging means such as transfermold packaging IC mounted on a lead frame by a mold material.

(4) By manufacturing a wireless tag by a mold technology such as transfer mode, a reduction in price can be achieved more than in an antenna constitution using a dielectric member substrate both faces of which are covered with copper. Further, although in the case of introducing a dielectric member substrate, IC has been difficult to contain, by introducing the mold technology such as transfer mold, IC can be contained easily and IC can easily be built in the wireless tag. Further, even in the case of discrete parts where a circuit of a wireless tag is not constituted by IC formation, the discrete parts can be contained at inside of the wireless tag and accordingly, the wireless tag can be manufactured with no significant change in the structure of the wireless tag from trial production to mass production.

(5) By achieving constant voltage formation by utilizing a unidirectional characteristic of LED such that power for driving a CMOS logic circuit or a memory produced by a rectenna circuit by approaching an interrogator antenna of a transmitter and receiver of a wireless tag is prevented from increasing and exceeding withstand voltage of the CMOS logic circuit or the memory circuit, extra power can be used as power for making LED emit light. By making LED attached with a luminous part at an antenna face of the wireless tag emit light, in the case in which wireless tags are dealt with in face to face, by irradiation of radio wave from an interrogator, an operating wireless tag can be confirmed by visual examination and therefore, by using the wireless tag in stocktaking of articles dealing with a number of wireless tags time-sequentially, operation of stocktaking is facilitated. Further, by introducing means for controlling light emission of LED by the CMOS logic circuit, response from the wireless tag to the interrogator can be dealt with by optical signal. Further, in the case of visual examination, by introducing a mechanism of winking set to respective specific operations, status check of the wireless tag or check by visual examination of operation can be carried out.

(6) aggregation of a total of a transmitter and receiver including LED, a CMOS logic circuit, a memory circuit and a rectenna circuit to a single chip of IC seems to be considerably difficult in view of an IC manufacturing process. It is inexpensive to prepare a chip individually for at least only LED and mount to mix with IC constituting other circuit in a single chip.

(7) According to the antenna for a wireless tag or the wireless tag by a quarter wavelength type microstrip-line of the present invention, the antenna effectively functions as a small-sized antenna in the case in which an antenna shape (length) is enlarged when the specific inductive capacity of the dielectric member is reduced and proximate to that of air by an antenna by a half wavelength type microstrip-line. An amount of a reduction in transmitting/receiving power by an effective area as an

antenna by shortening the length of the antenna can be compensated for since high function formation can be achieved by using air or a dielectric member near to air.

[0055] It is further understood by those skilled in the art that the foregoing description is a preferred embodiment of the disclosed device and that various changes and modifications may be made in the invention without departing from the spirit and scope thereof.

Claims

1. A wireless tag comprising:

a half-wavelength resonator in a microstrip-line constitution having an antenna (13, 19, 25, 28, 29, 32, 51, 58, 66, 73, 81, 87, 93, 100, ...), an earth conductor (15, 21, 39, 53, 60, 68, 75, 83, 89, 95, ...) and a dielectric member (14, 20, 26, 30, 30, 37, 38, 40, 41, 52, 59, 67, 72, 80, 74, 82, 88, 99, ...) between the antenna and the earth conductor; and
a single or a plurality of line conductors for connecting a middle point of the antenna and the earth conductor.

2. A wireless tag according to claim 1, wherein line lengths (11, 12) from the middle point of the antenna to respective open ends thereof differ from each other.

3. A wireless tag according to claim 1, wherein line widths (W1, W2) from the middle point of the antenna to respective open ends thereof differ from each other.

4. A wireless tag according to claim 1, wherein line lengths and line widths from the middle point of the antenna to respective open ends thereof differ from each other.

5. A wireless tag according to claim 1, wherein a portion of the dielectric member is air (37, 38, 72, 80).

6. A wireless tag according to claim 1, wherein all of the dielectric member is air.

7. A wireless tag according to claim 1, further comprising:

a feed point (16, 23) on an antenna conductor from the middle point of the antenna to any of open ends thereof.

8. A wireless tag according to claim 1, further comprising:

a feed line connected to an end face of an antenna conductor from the middle point of the antenna to any of open ends thereof.

9. A wireless tag according to claim 7, further comprising:

a feed line for connecting the feed point and the earth conductor by penetrating the dielectric member.

10. A wireless tag according to claim 1, wherein the dielectric member is arranged only at a gap at which a face of the antenna and a face of the earth conductor are opposed to each other.

11. A wireless tag according to claim 1, wherein the earth conductor covers end faces of the dielectric member.

12. A wireless tag according to claim 1, further comprising:

an electric circuit (57, 65, 72) or an IC between the antenna and the earth conductor.

13. A wireless tag according to claim 12, wherein the antenna includes a hole (18, 22, 27, 31, 34, 38, 49, 61, 69, 76, ...) and the dielectric member is provided also in the hole.

14. A wireless tag according to claim 1, wherein the antenna comprises a rectangular conductor and two of the line conductors are provided and connected to the earth conductor respectively from two locations constituting the middle point of the antenna.

15. A method of manufacturing a wireless tag, wherein said wireless tag is formed by an earth conductor forming five faces of a rectangular parallelepiped and a mircostrip-line of an antenna conductor formed at a remaining face thereof and a resin in a liquid state is injected and solidified at inside of the earth conductor as a dielectric member.

16. A method of manufacturing a wireless tag, wherein an antenna conductor provided with a line conductor is arranged with an electric circuit or an IC, the electric circuit or the IC is molded with a resin in a liquid state to solidify to cover the electric circuit or the IC and thereafter, an earth conductor is connected to the line conductor.

17. A wireless tag comprising:

quarter-wavelength resonators (28, 29) in a

microstrip-line constitution having an antennna, an earth conductor and a dielectric member (30) between the antenna and the earth conductor;
wherein one end of the antenna is connected to the earth conductor via a line conductor or a conductor line.

18. A wireless tag according to claim 17, further comprising:

a feed line one end of which is connected to a feed point of the antenna and which is penetrated to a side of the earth conductor.

19. A wireless tag according to claim 17, wherein a width of the conductor line is a width different from a width of the antenna.

20. A wireless tag according to claim 17, further comprising:

an electric circuit or an IC provided between a feed point of the antenna and the conductive line.

21. A wireless tag comprising:

an antenna;
a transmitter and receiver including a rectenna circuit;
a CMOS logic circuit;
a memory circuit; and
an LED for emitting light by power generated by the rectenna circuit (Figs. 41-44).

22. A wireless tag according to claim 21, wherein the LED emits light by power via the CMOS logic circuit.

23. A wireless tag according to claim 21, wherein the transmitter and receiver, the CMOS logic circuit and the memory circuit are constituted by a single chip of IC.

24. A wireless tag according to claim 21, wherein light emission of the LED is arranged at a position capable of being confirmed on a side of the antenna.

25. A wireless tag according to claim 24, wherein light emission of the LED can be confirmed via a hole provided at the antenna.

26. A method of arranging a wireless tag, wherein a side of an earth conductor of a wireless tag in a microstrip-line constitution having an antenna, the earth conductor and a dielectric member between the antenna and the earth conductor is arranged to be brought into contact with an object.

27. A method of arranging a wireless tag according to claim 26,
wherein an adhesive sealing is provided on the side of the earth conductor and is pasted on the object.

FIG. 1

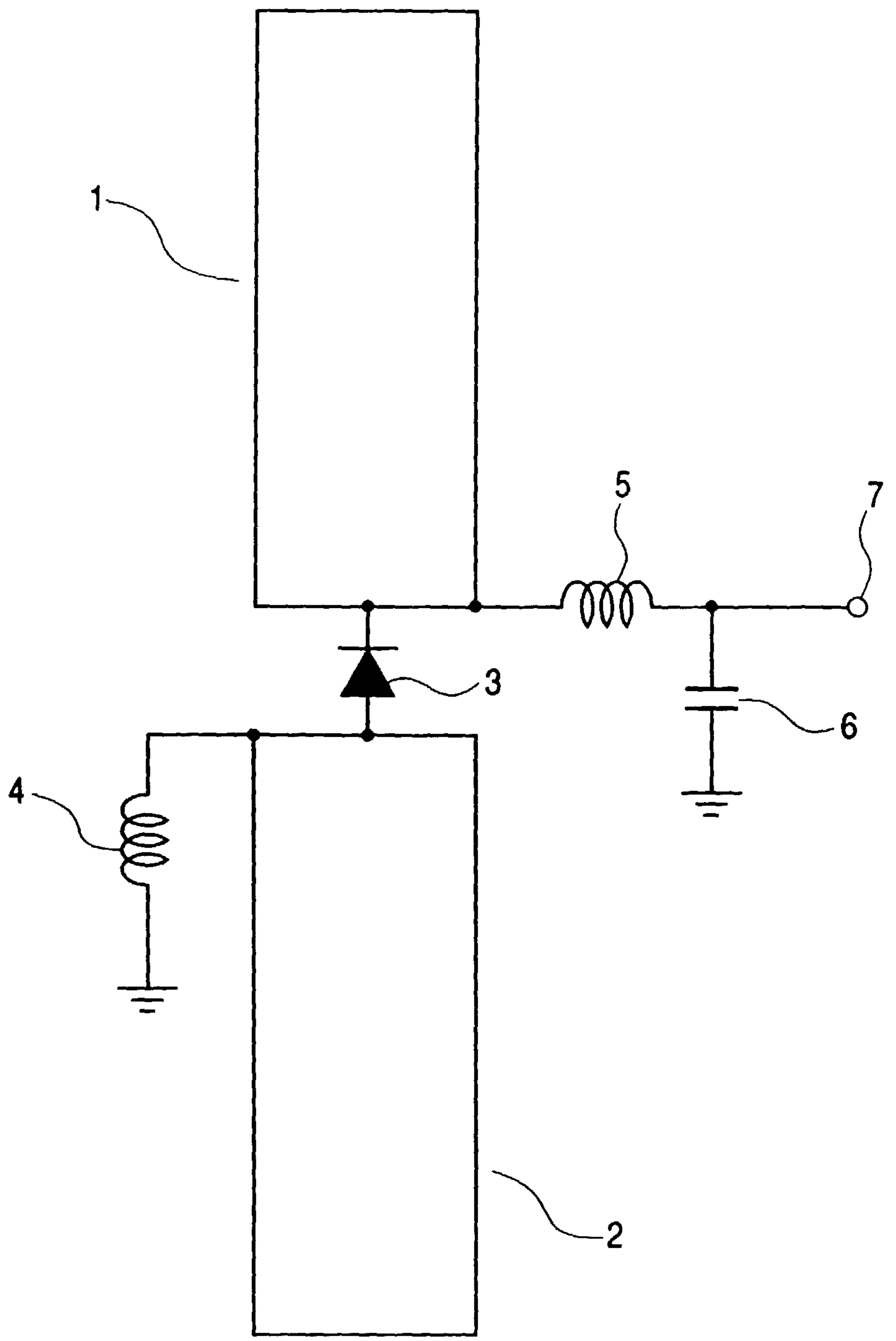


FIG. 2A

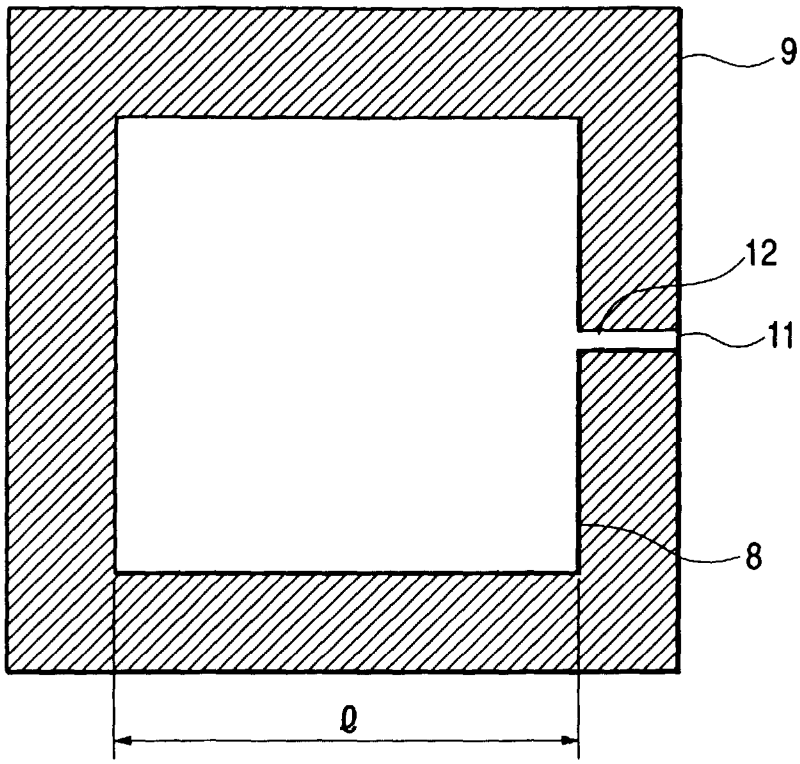


FIG. 2B

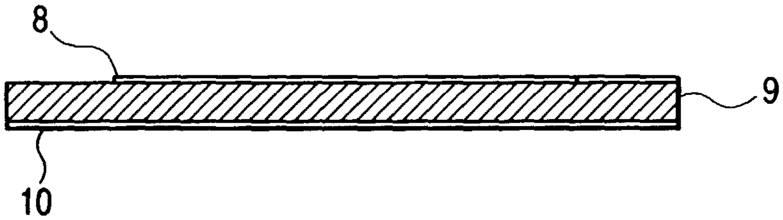


FIG. 2C

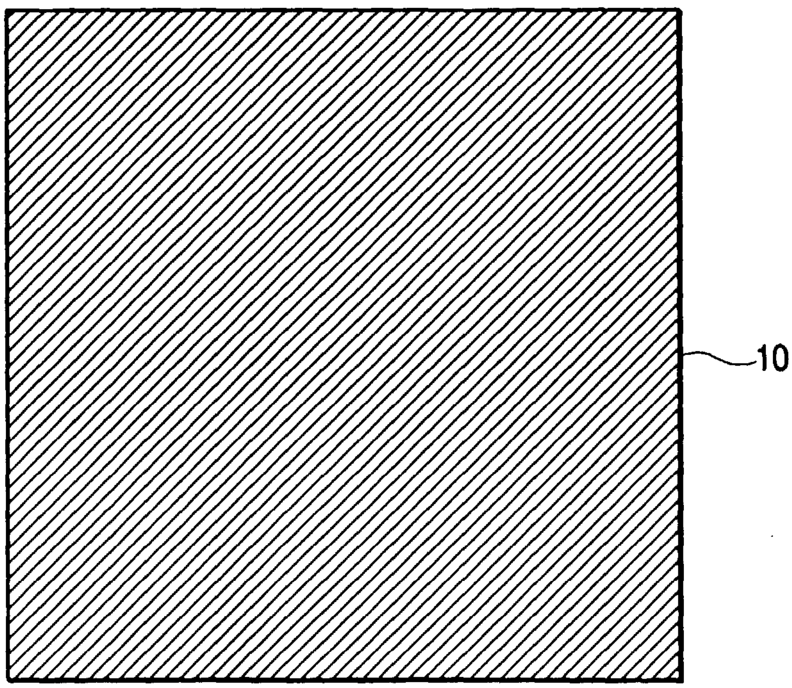


FIG. 3A

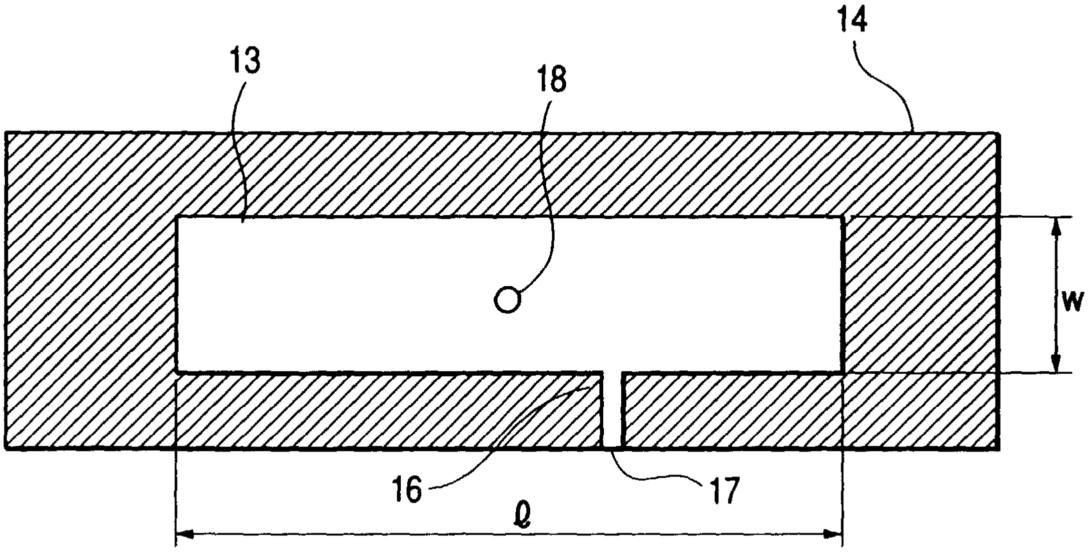


FIG. 3B

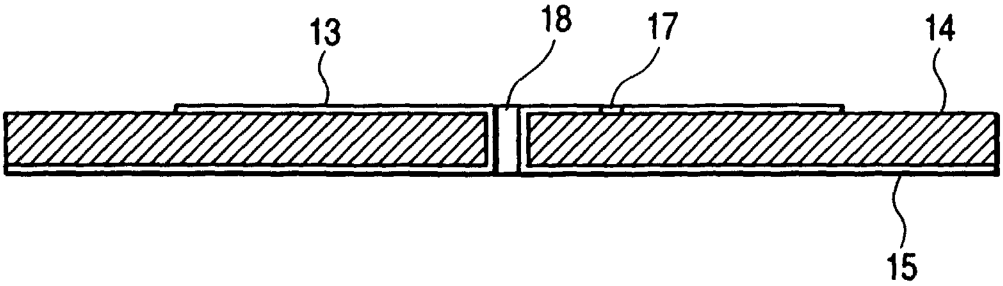


FIG. 3C

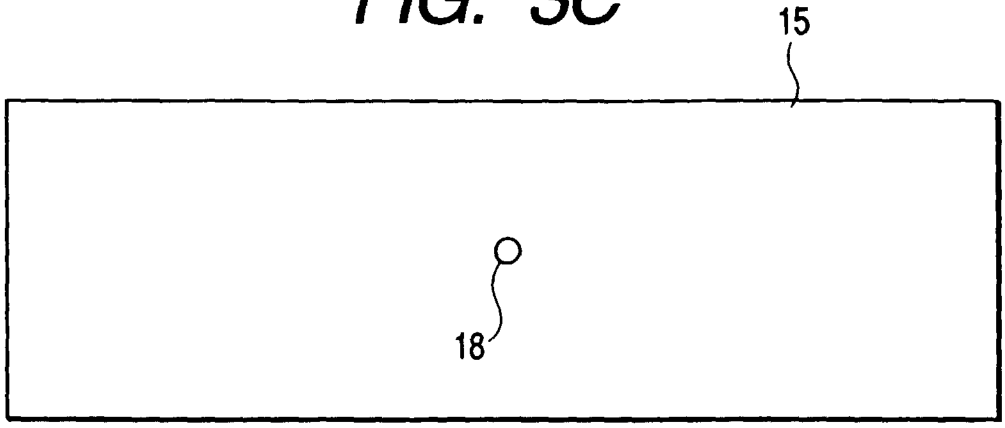


FIG. 4

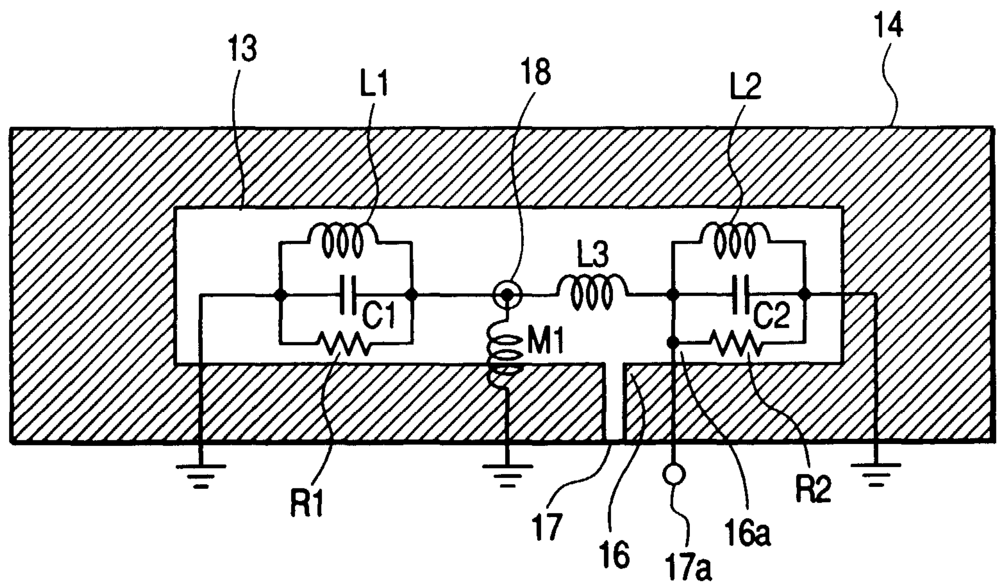


FIG. 5A

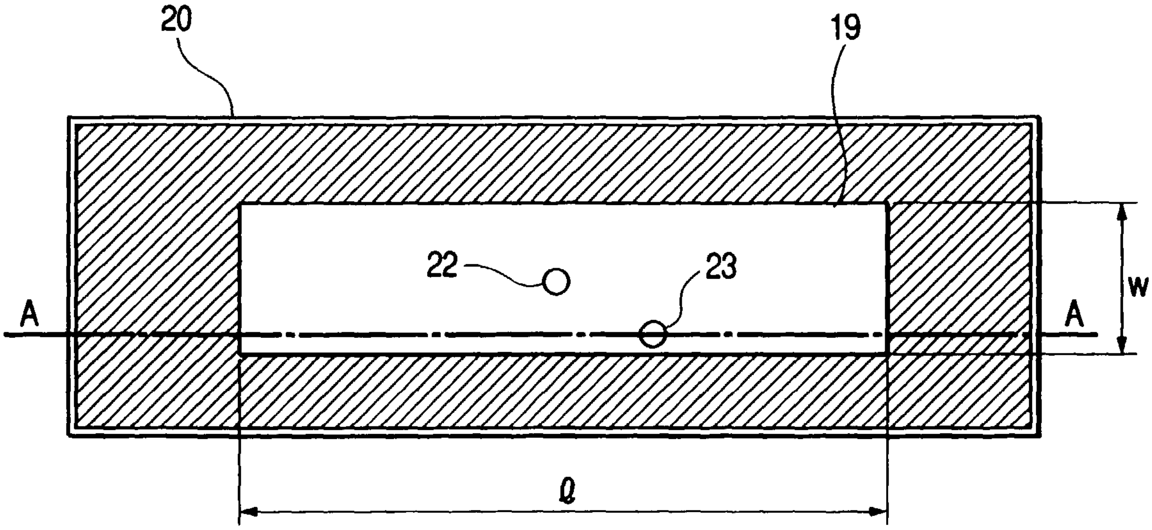


FIG. 5B

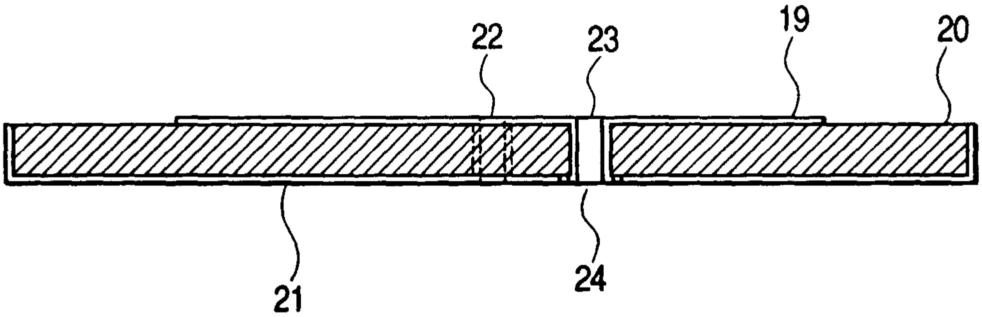


FIG. 5C

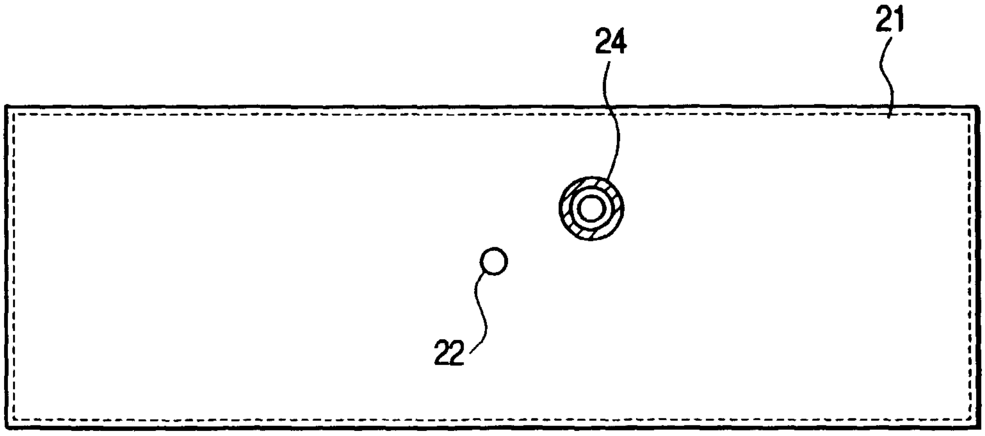


FIG. 6

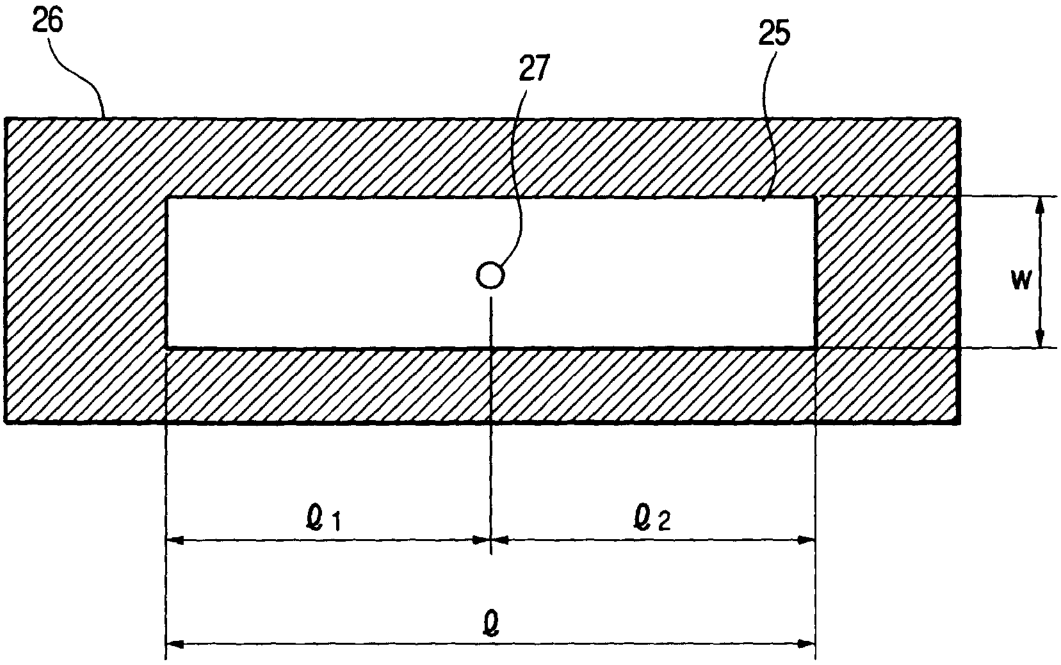


FIG. 7

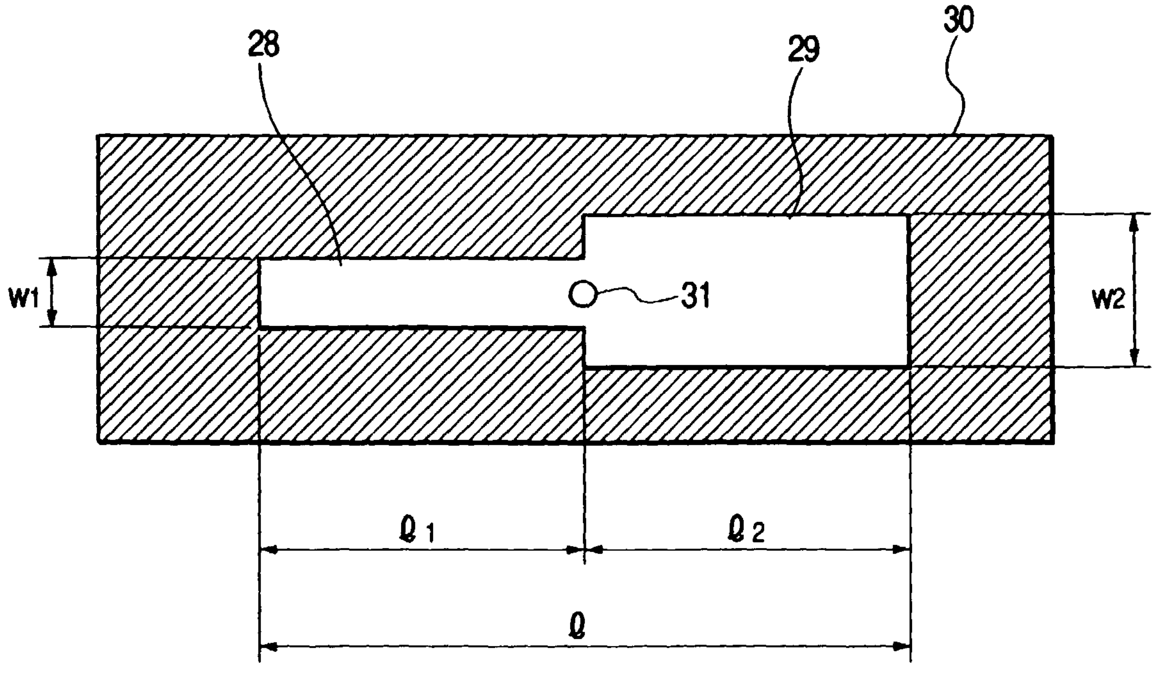


FIG. 8A

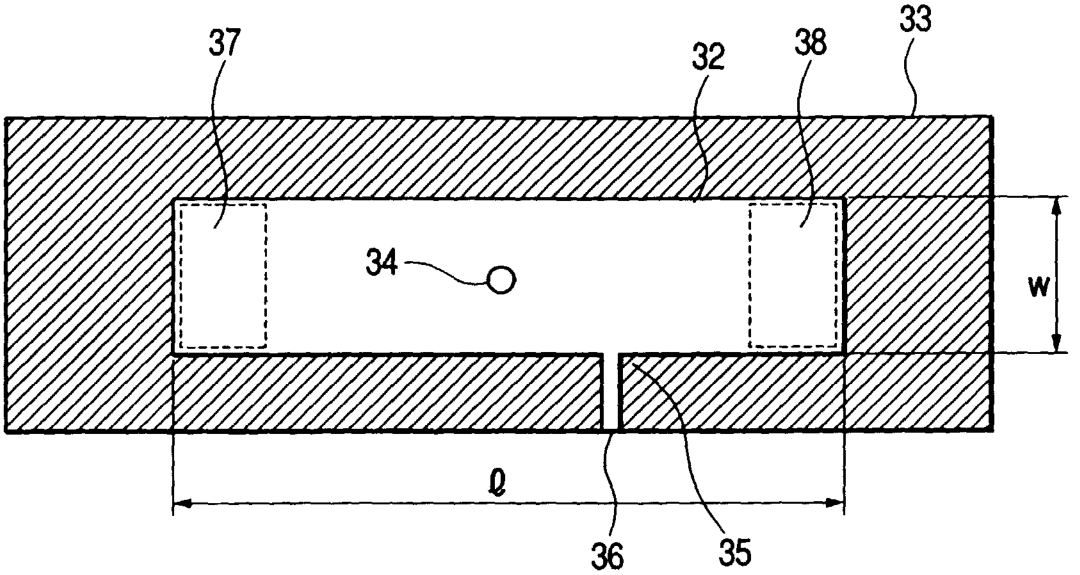


FIG. 8B

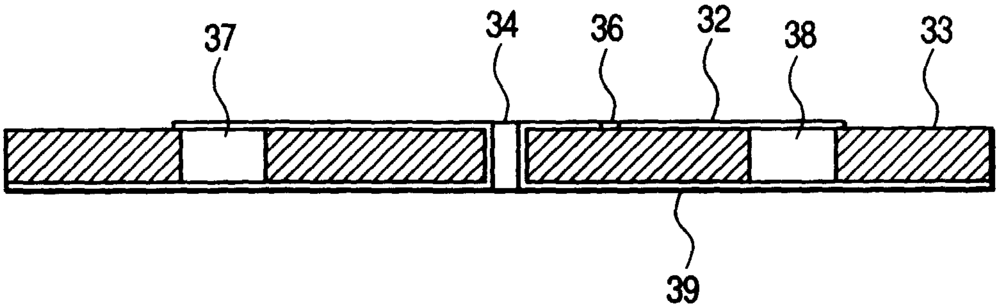


FIG. 8C

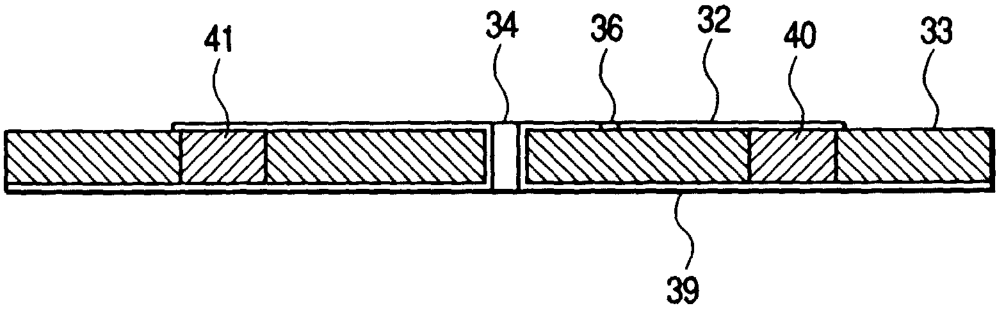


FIG. 9A

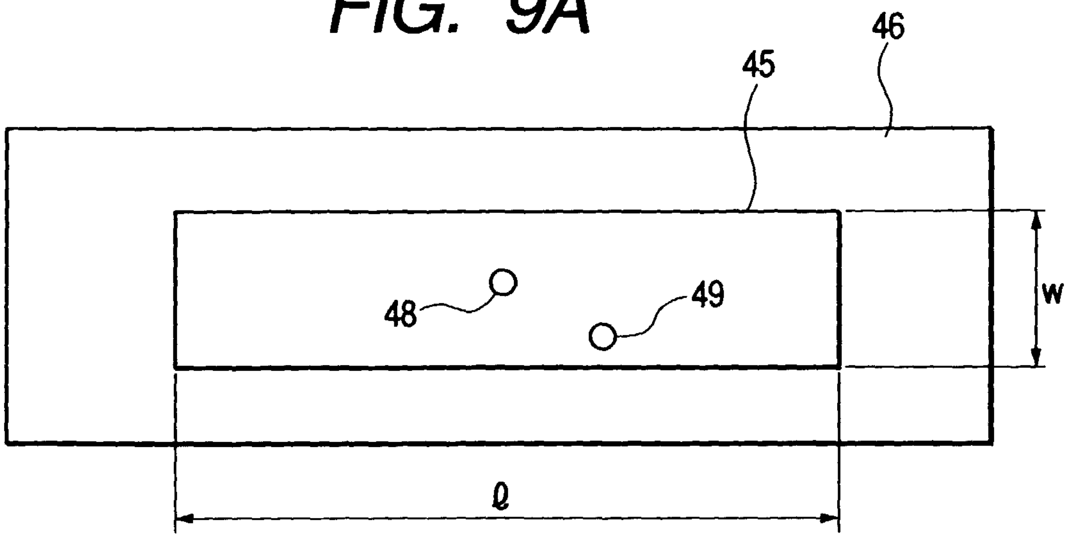


FIG. 9B

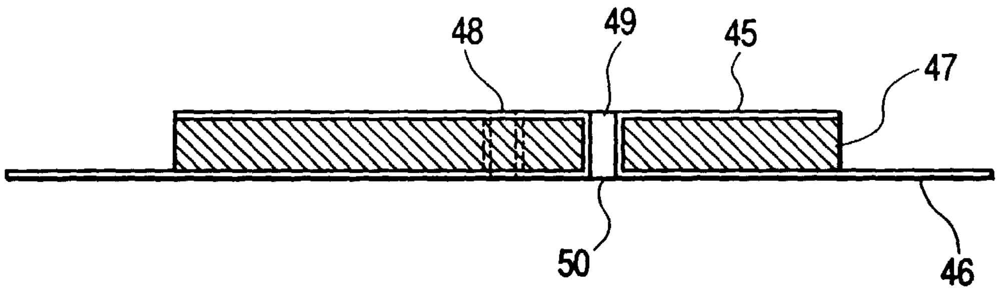


FIG. 9C

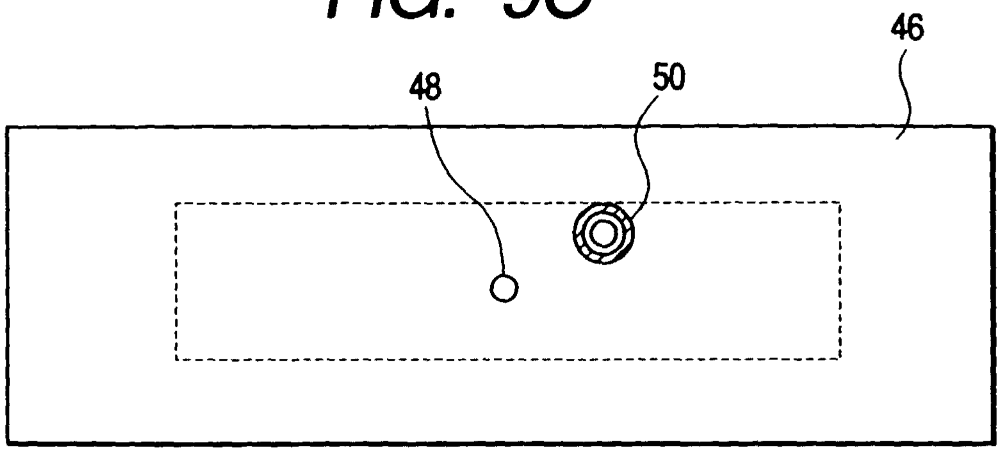


FIG. 10A

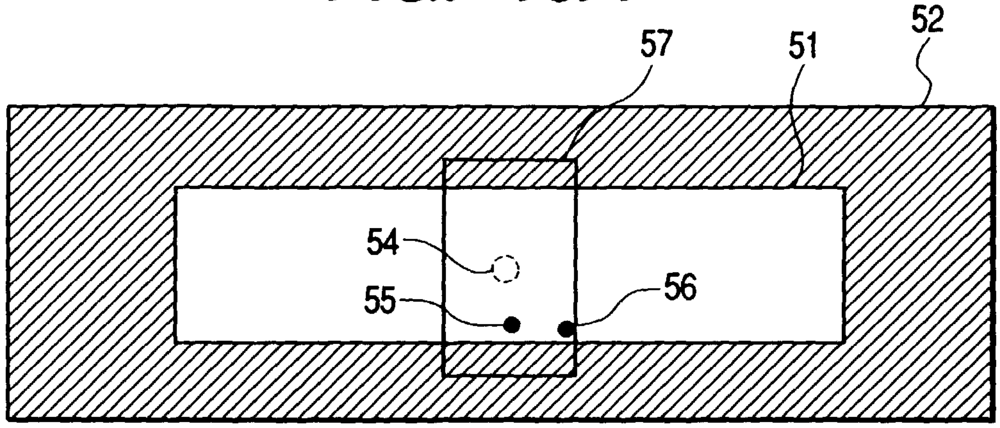


FIG. 10B

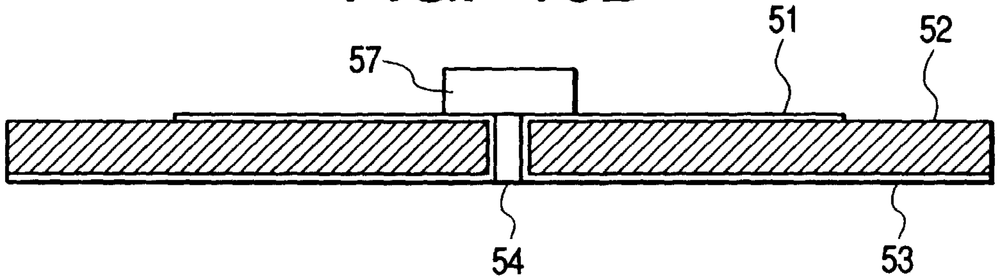


FIG. 11A

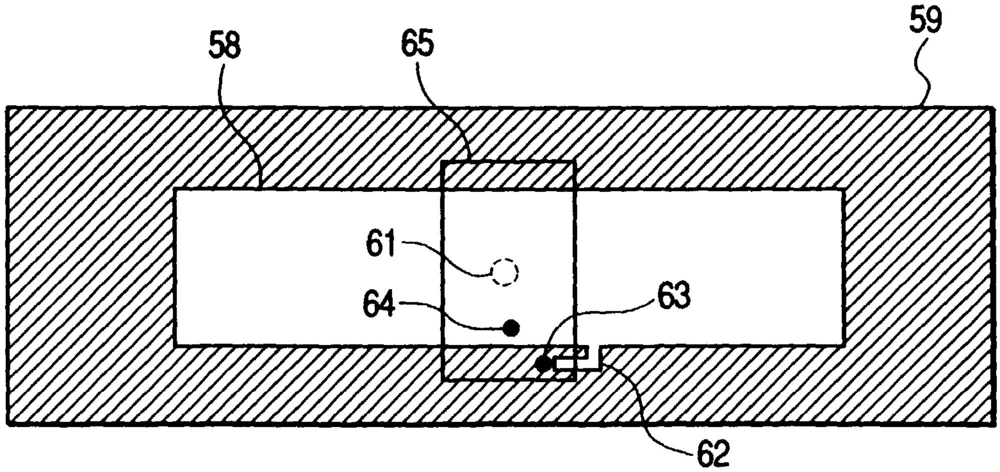


FIG. 11B

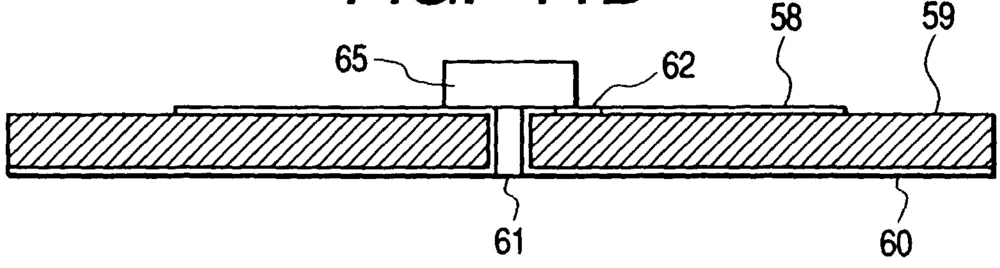


FIG. 12A

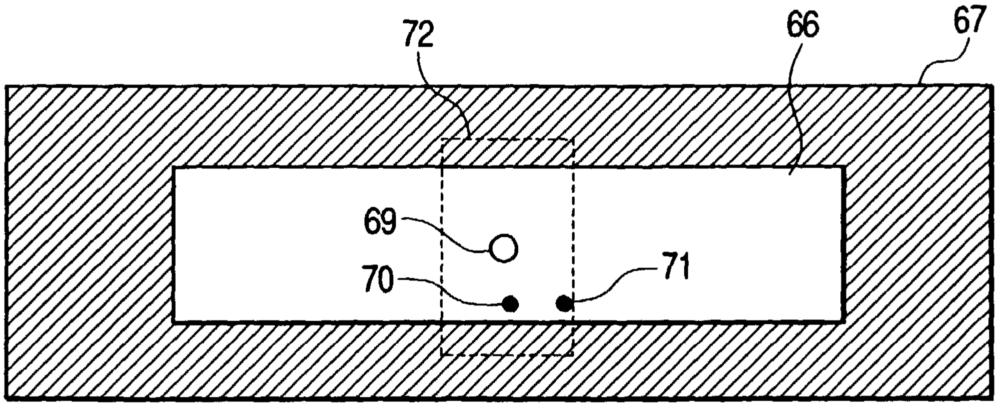


FIG. 12B

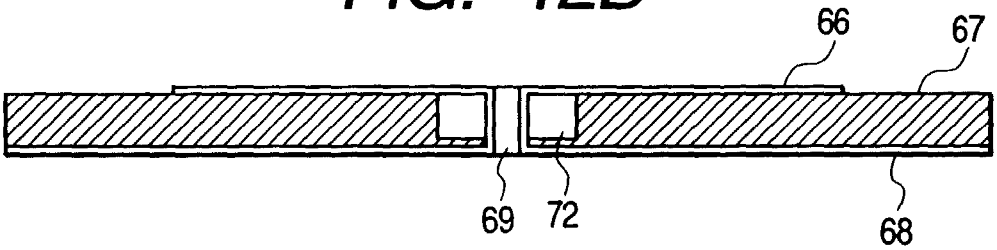


FIG. 13A

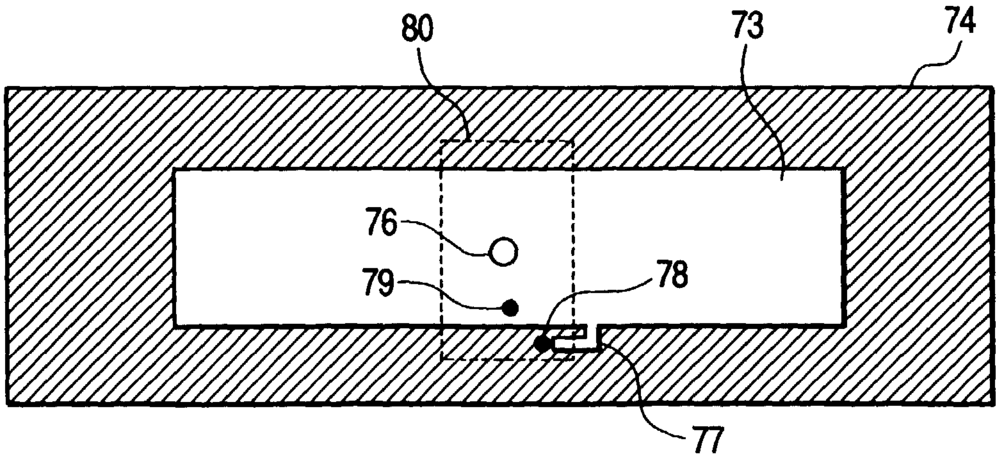


FIG. 13B

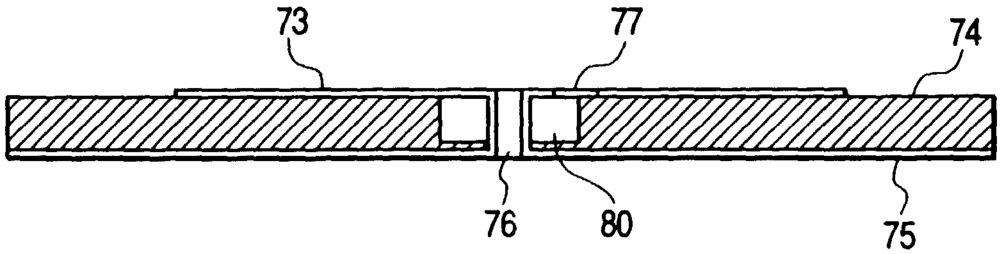


FIG. 14A

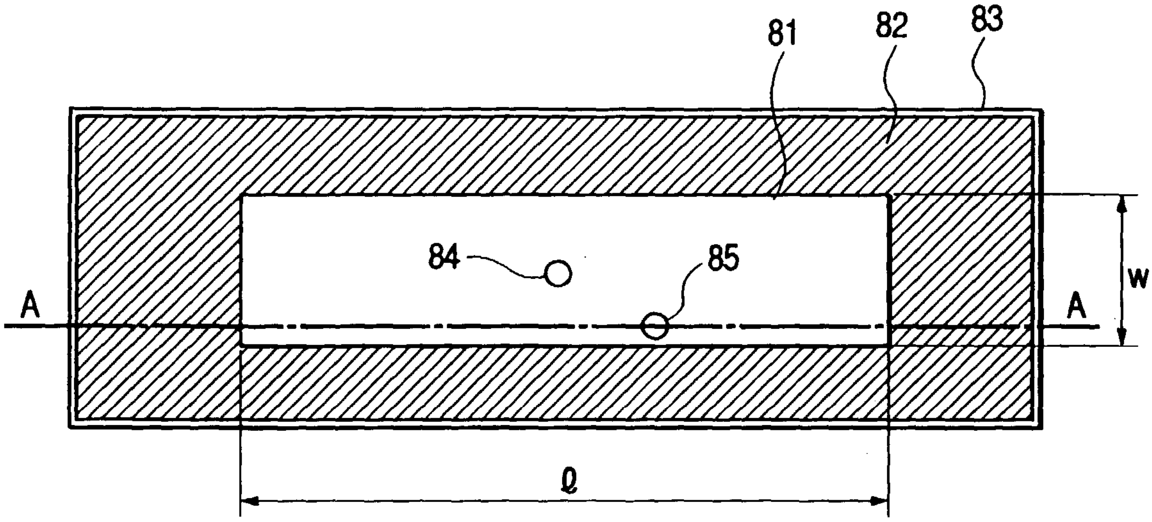


FIG. 14B

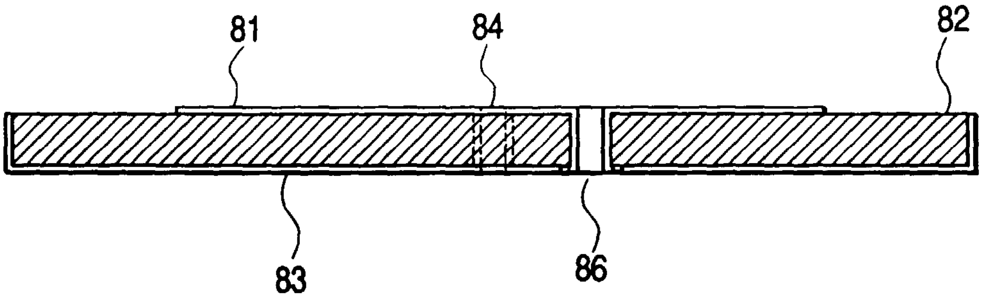


FIG. 14C

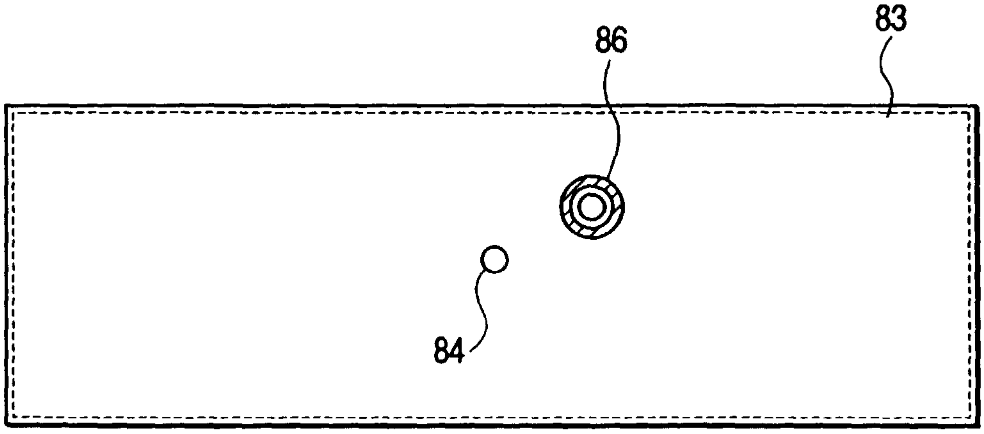


FIG. 15A

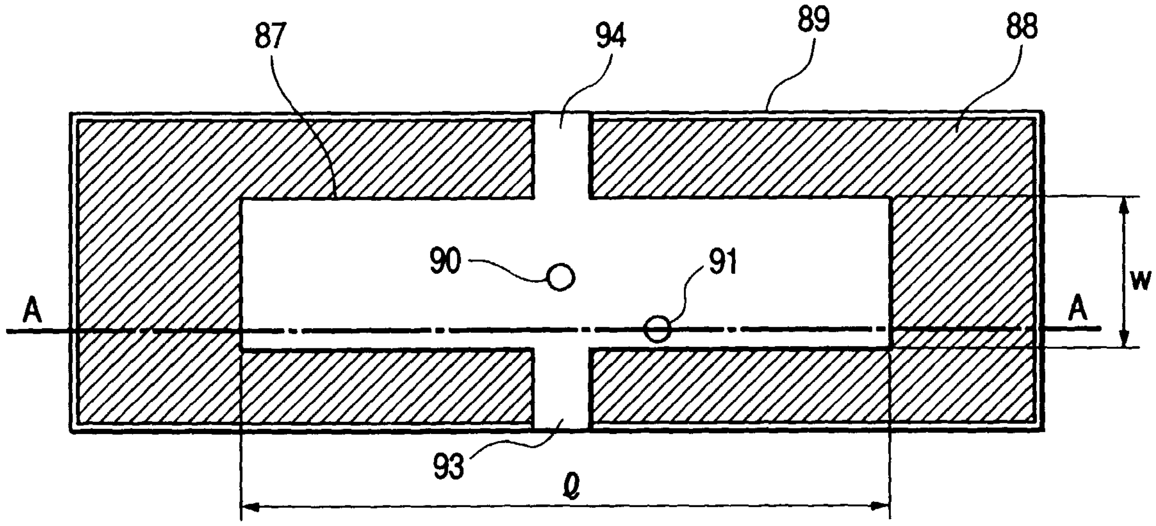


FIG. 15B

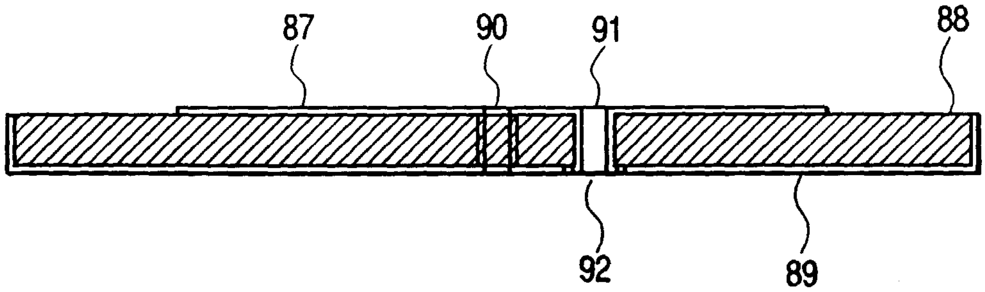


FIG. 15C

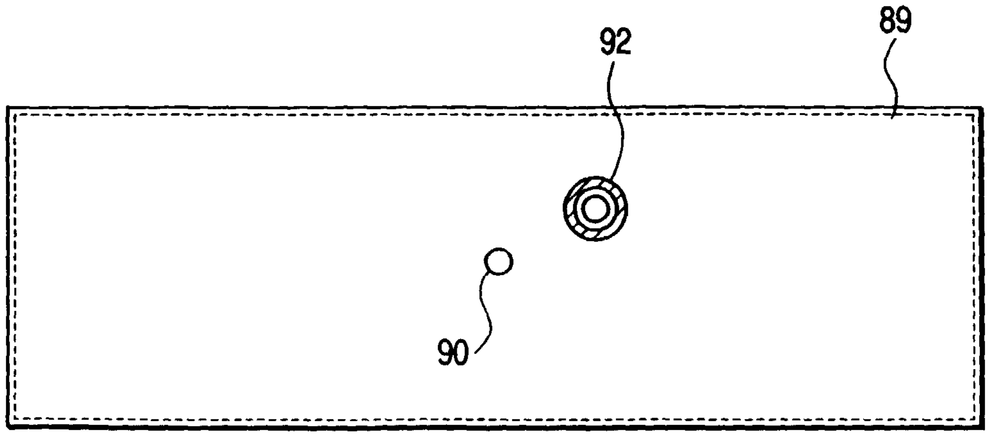


FIG. 16A

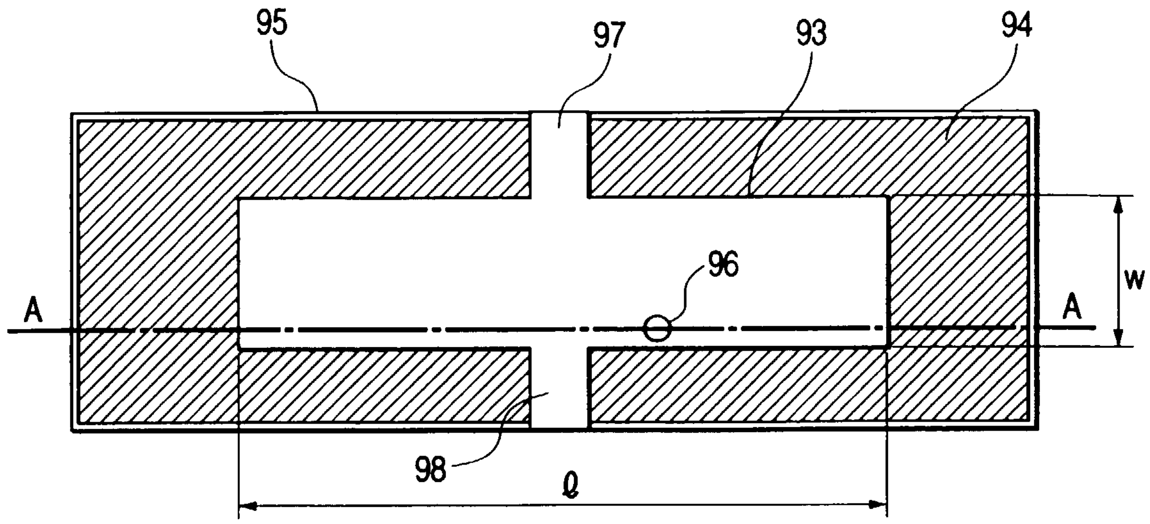


FIG. 16B

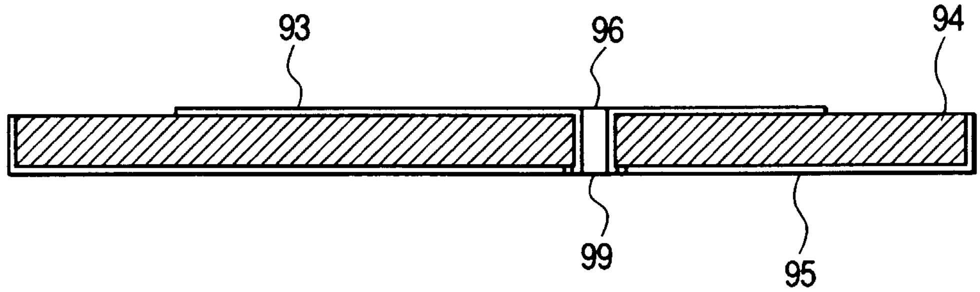


FIG. 16C

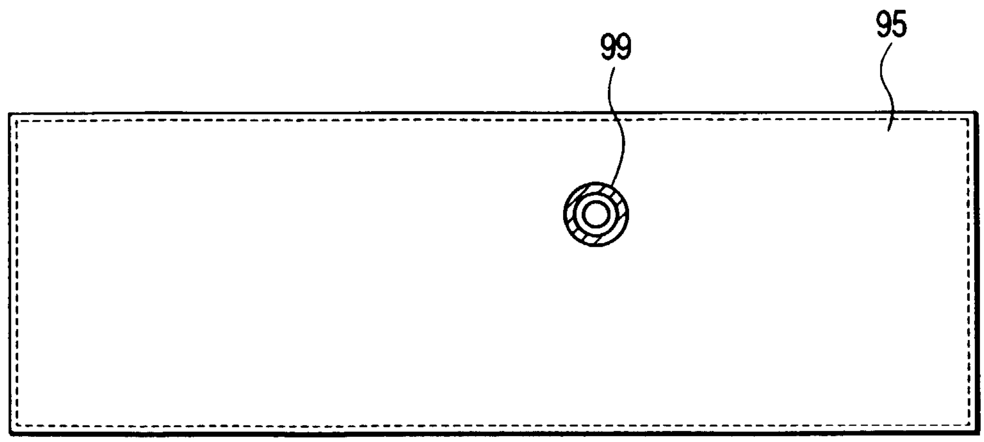


FIG. 17A

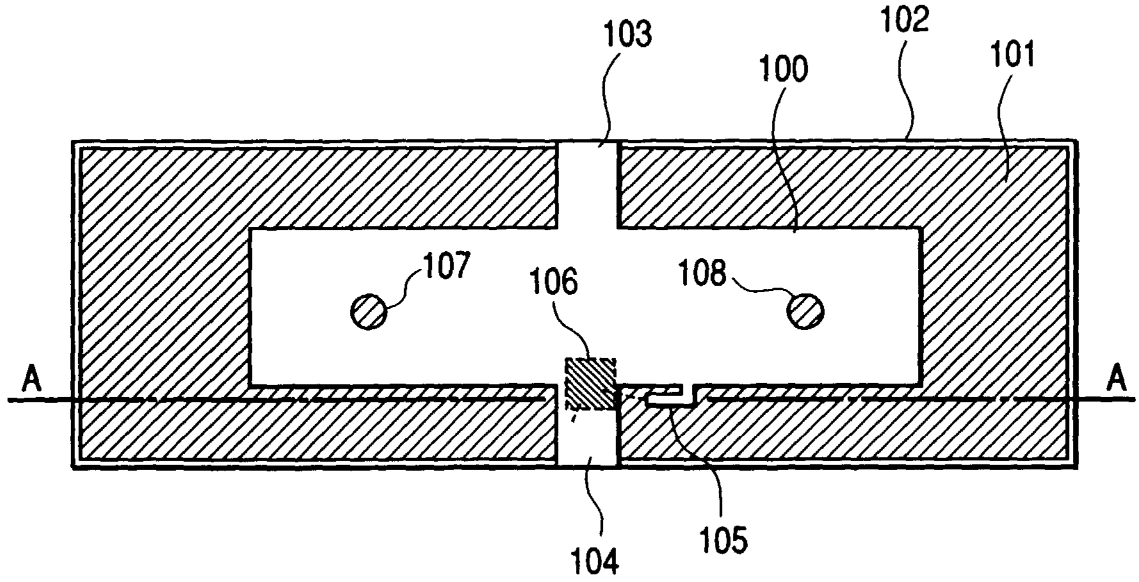


FIG. 17B

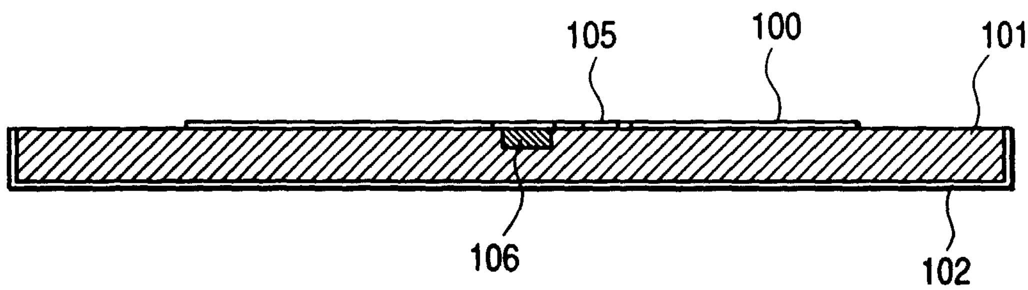


FIG. 17C

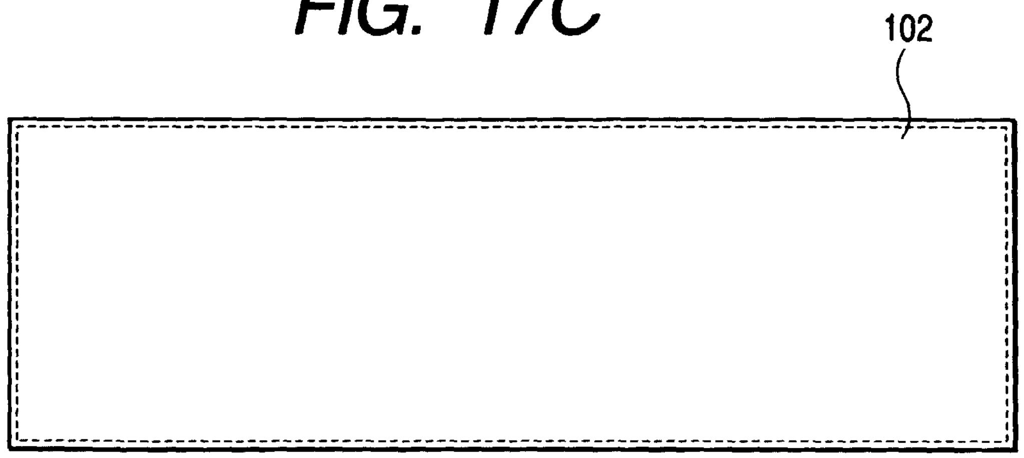


FIG. 18A

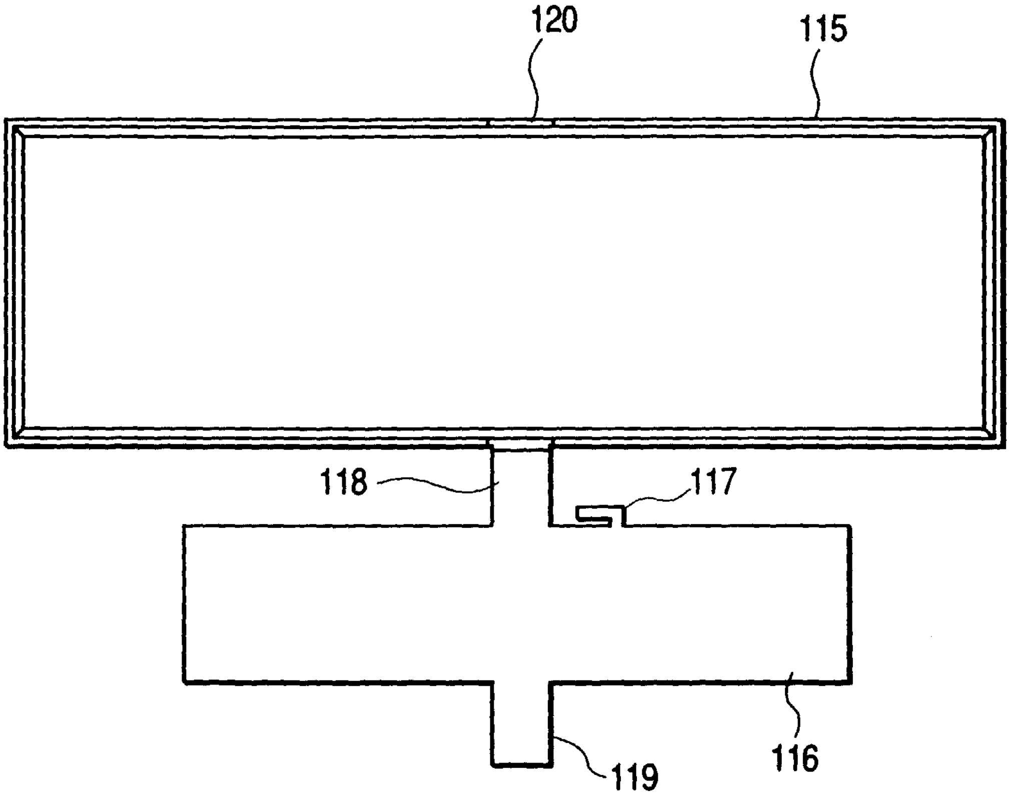


FIG. 18B

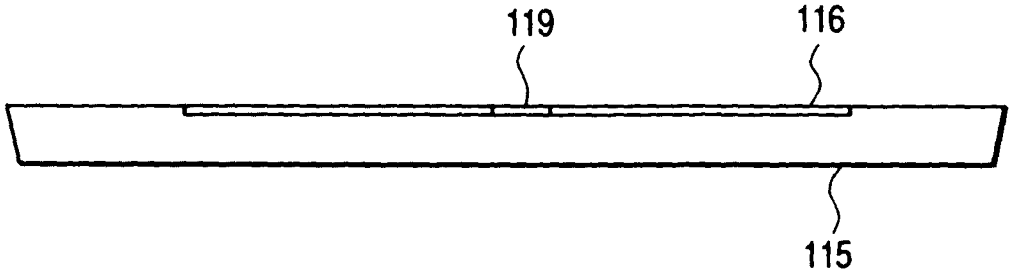


FIG. 19A

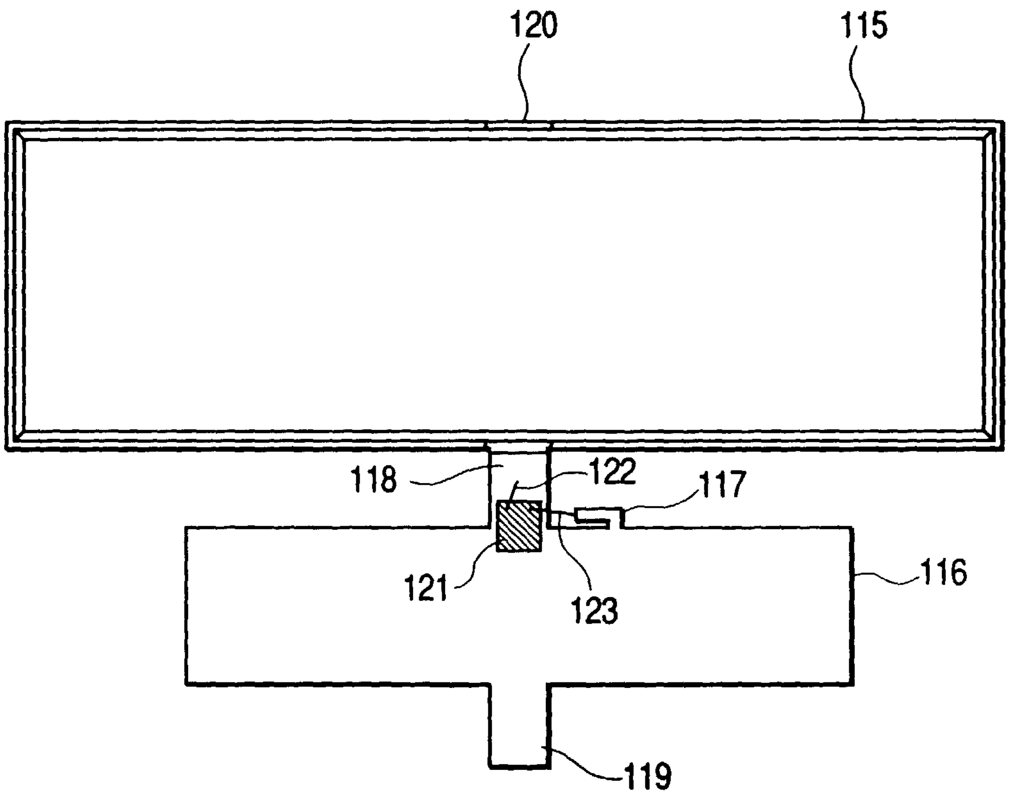


FIG. 19B

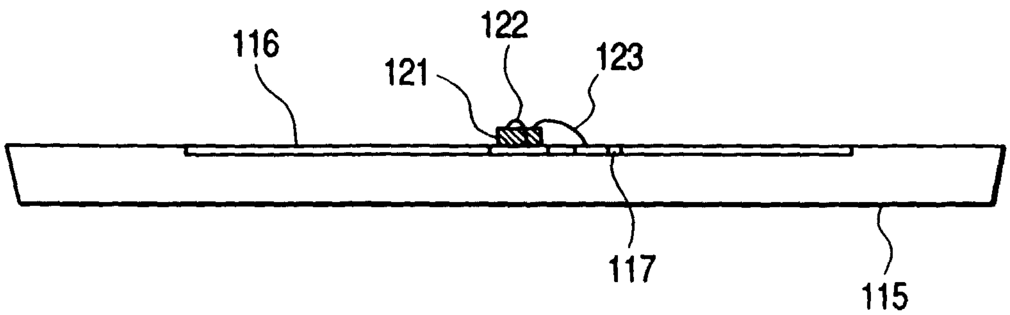


FIG. 20A

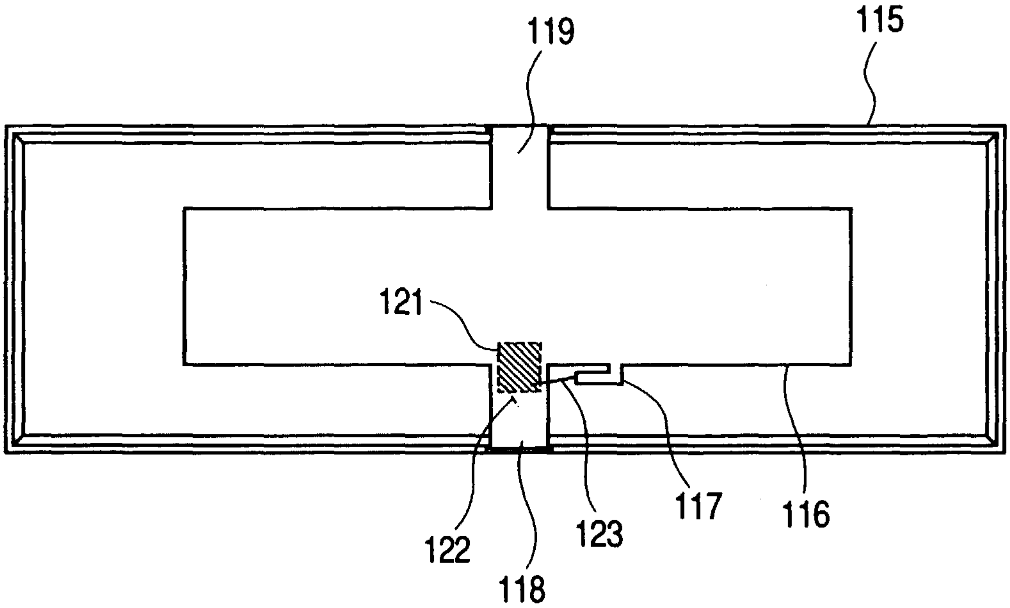


FIG. 20B

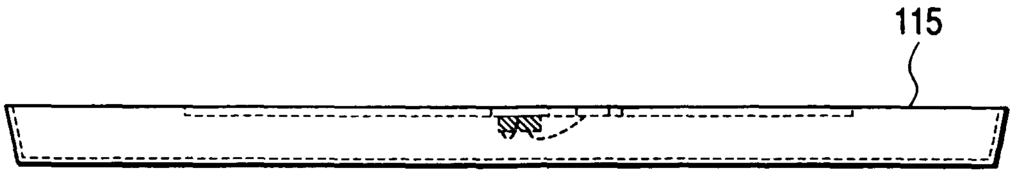


FIG. 21A

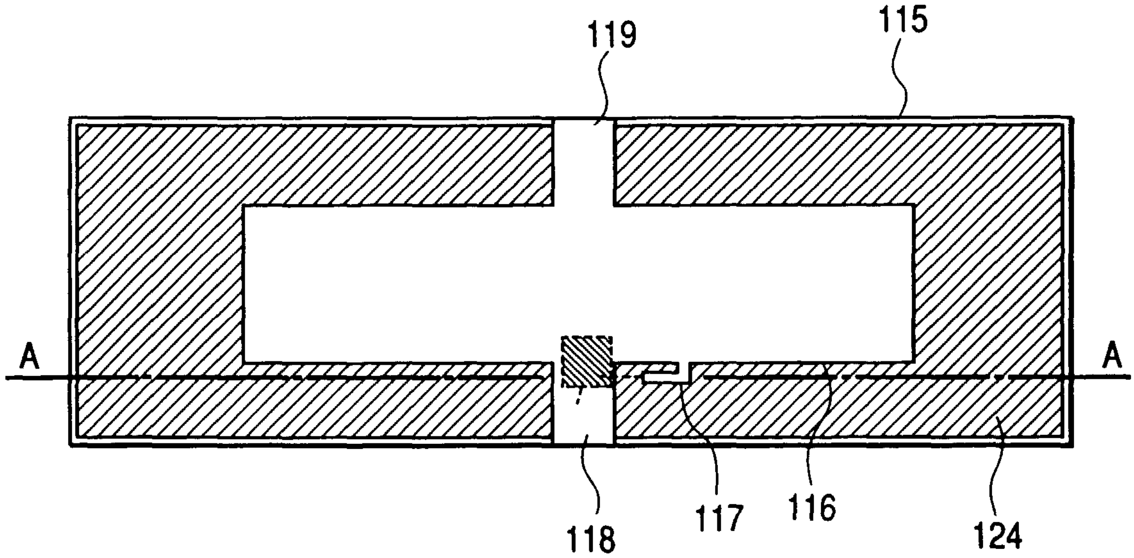


FIG. 21B

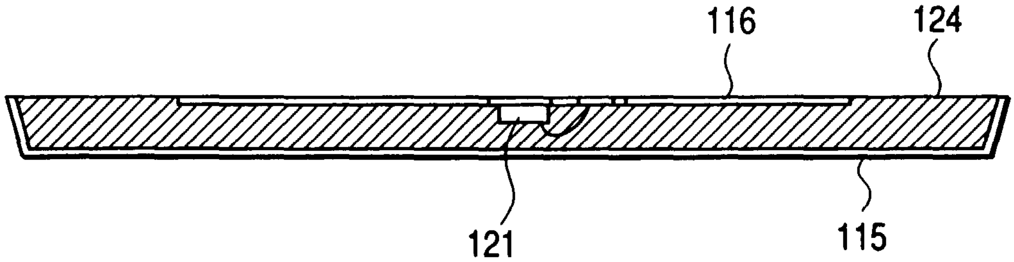


FIG. 21C

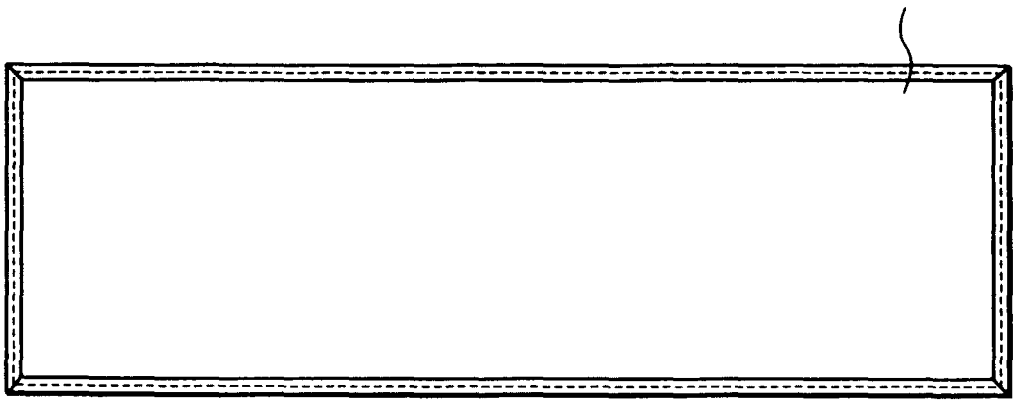


FIG. 22A

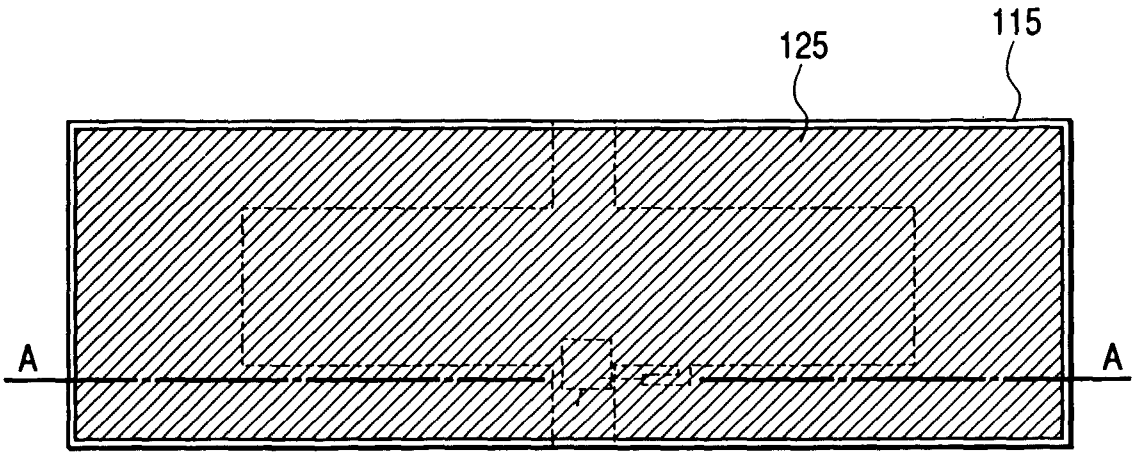


FIG. 22B

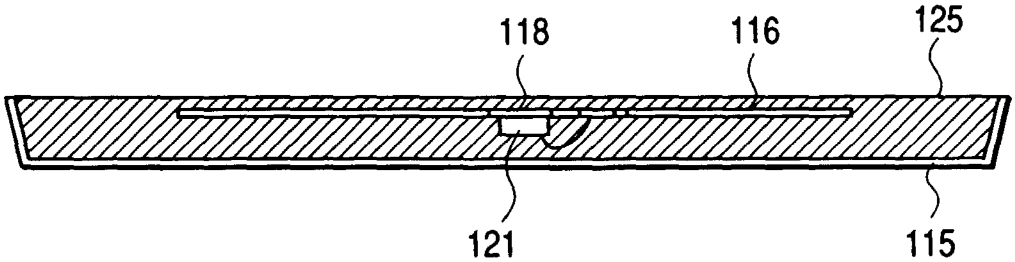


FIG. 22C

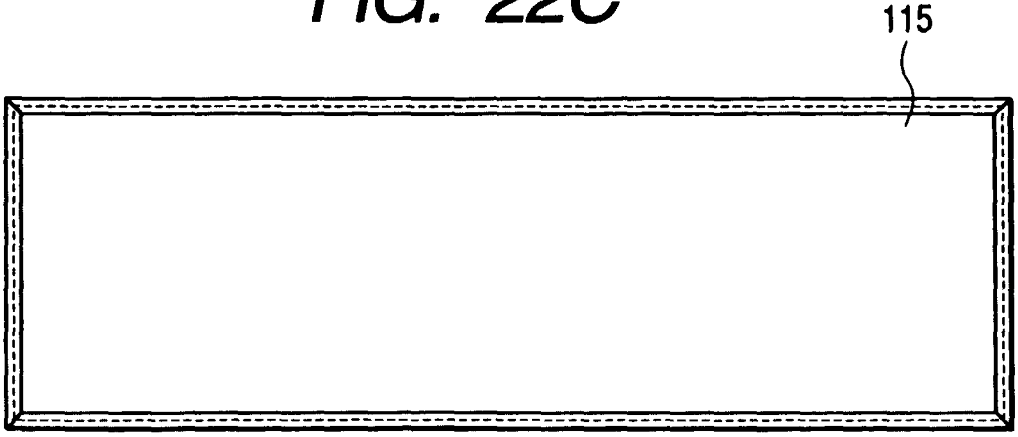


FIG. 23

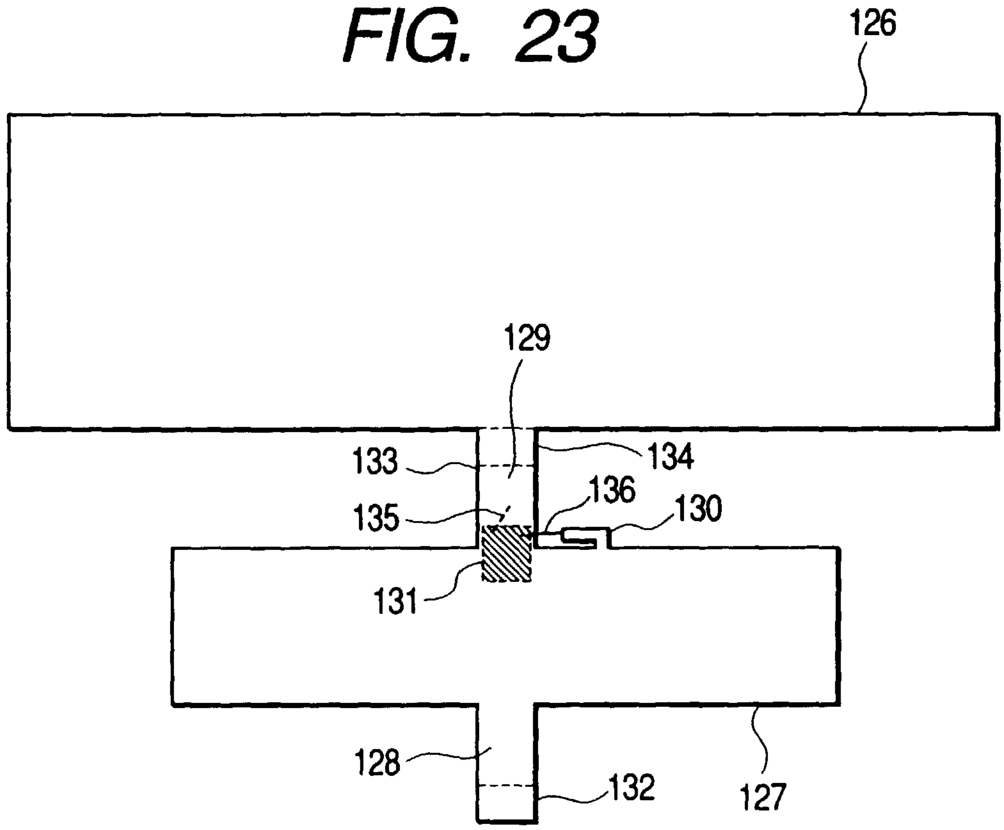


FIG. 24A

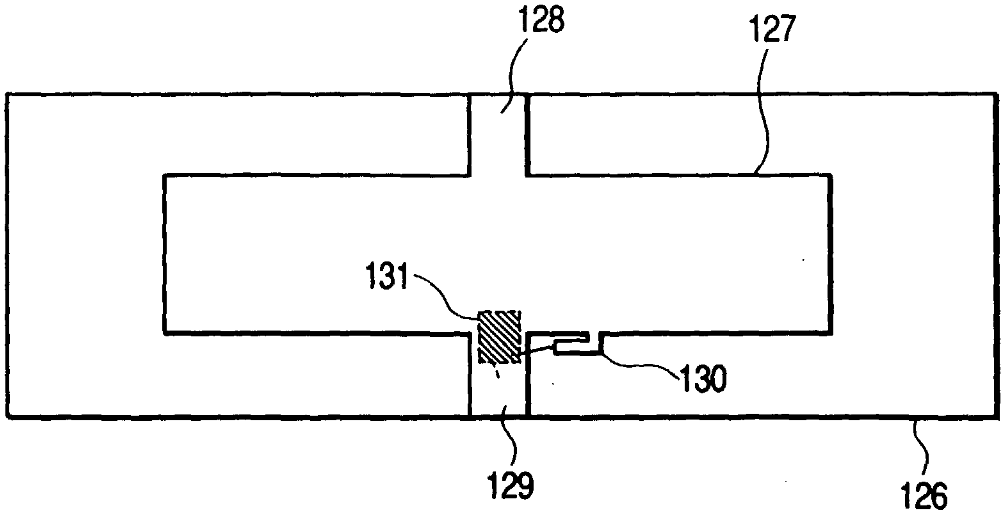


FIG. 24B

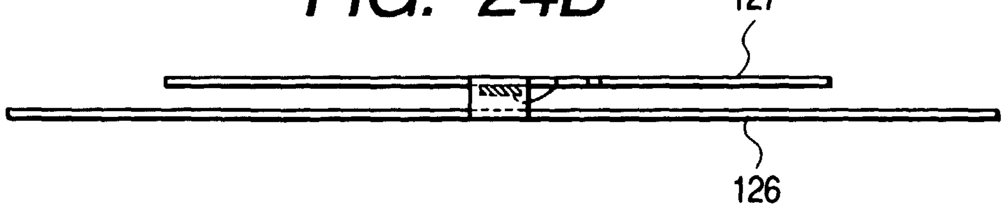


FIG. 25A

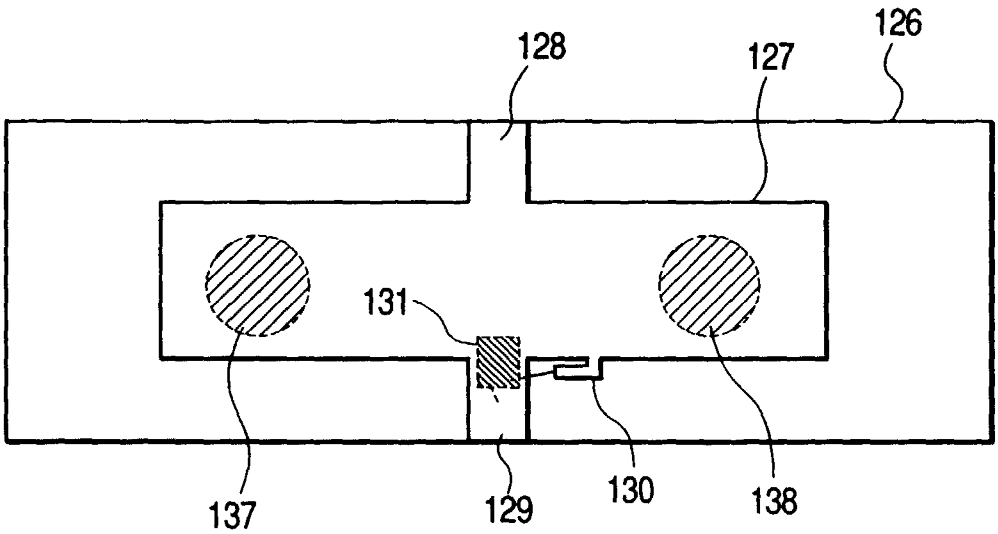


FIG. 25B

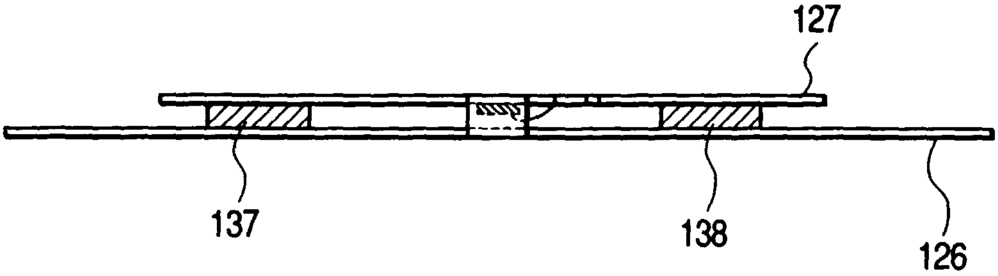


FIG. 26A

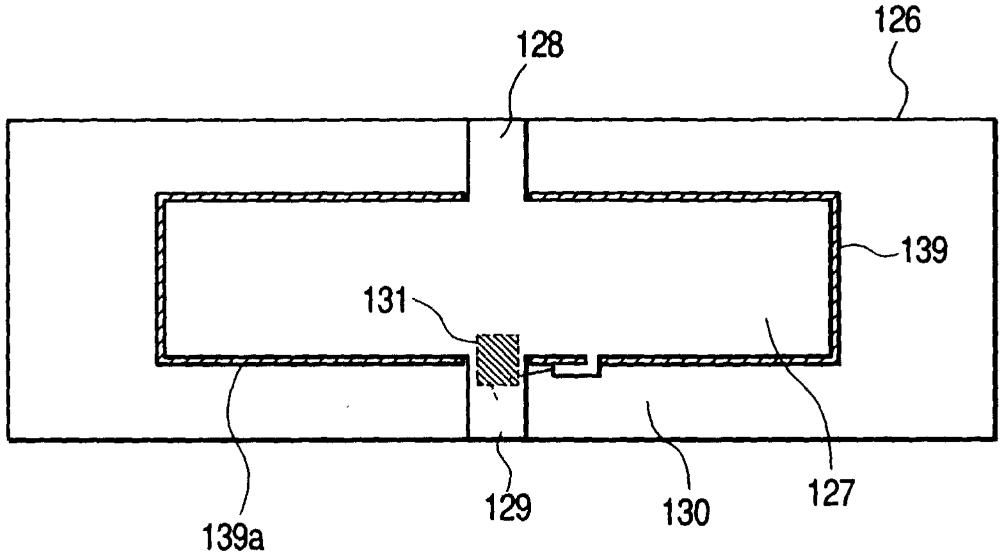


FIG. 26B

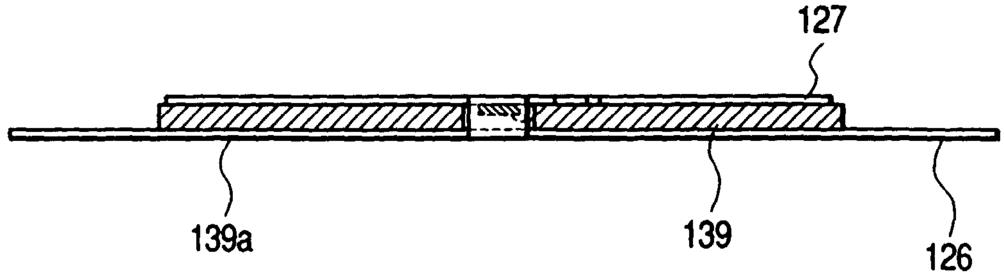


FIG. 27A

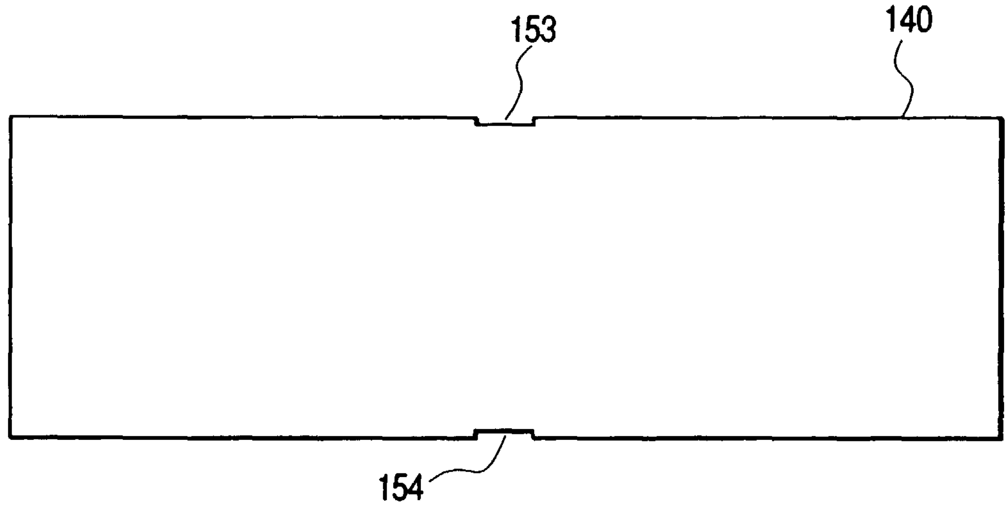


FIG. 27B

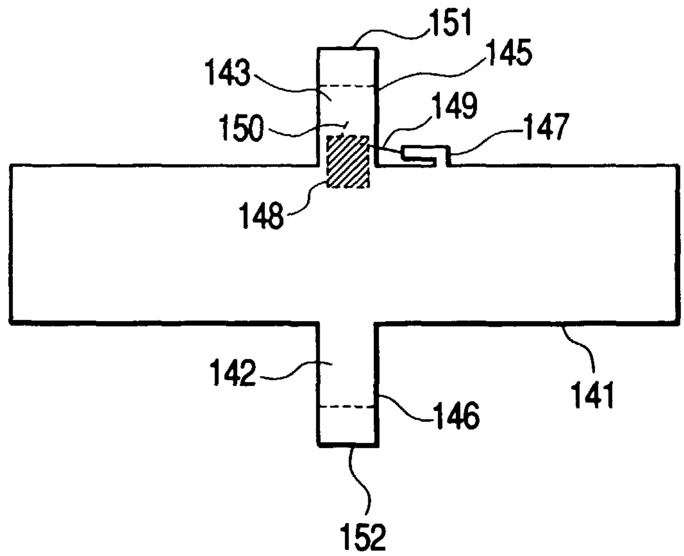


FIG. 27C

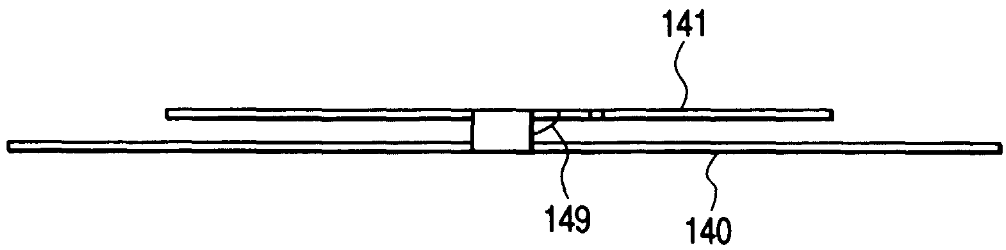


FIG. 28A

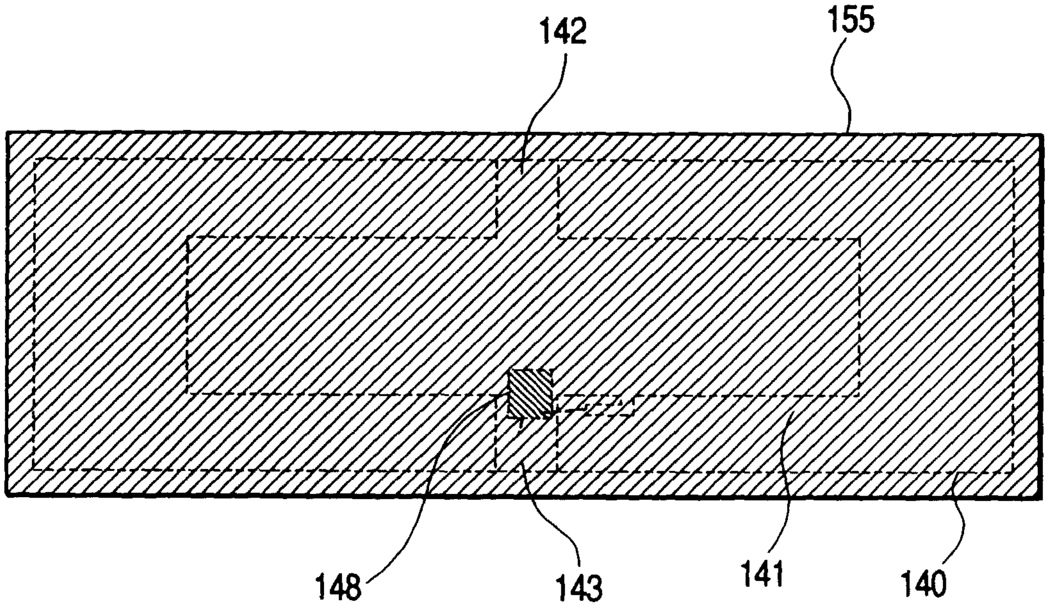


FIG. 28B

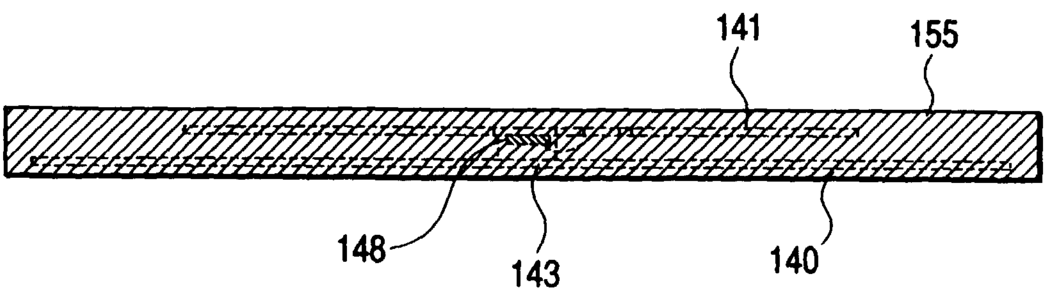


FIG. 29A

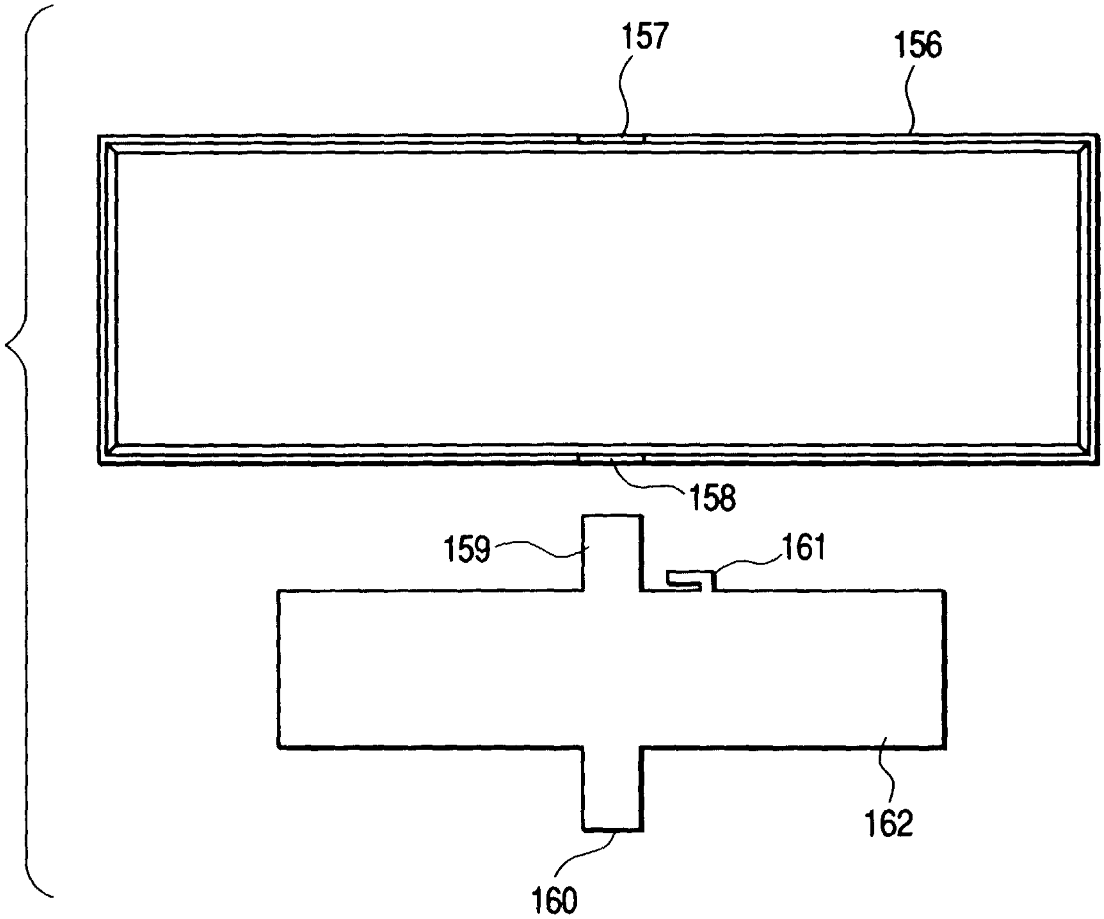


FIG. 29B

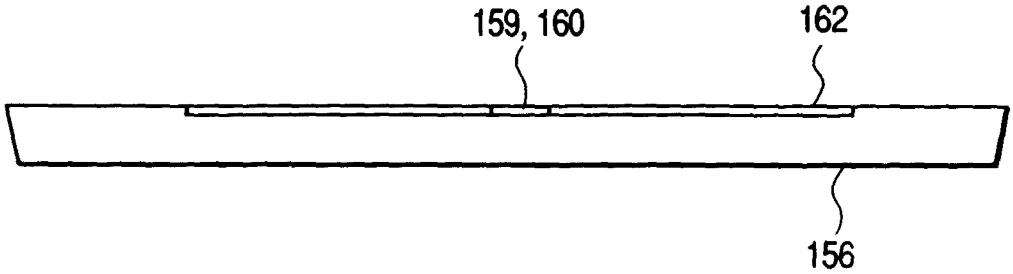


FIG. 30A

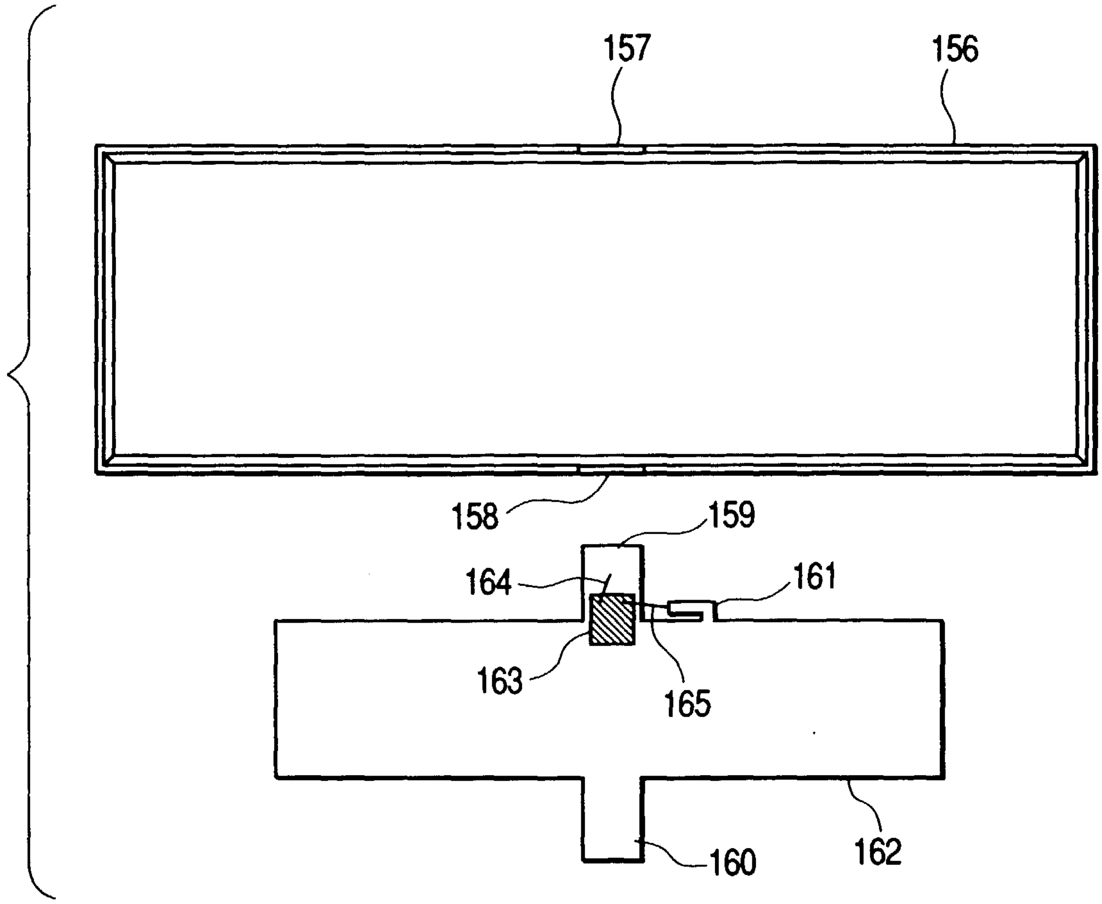


FIG. 30B

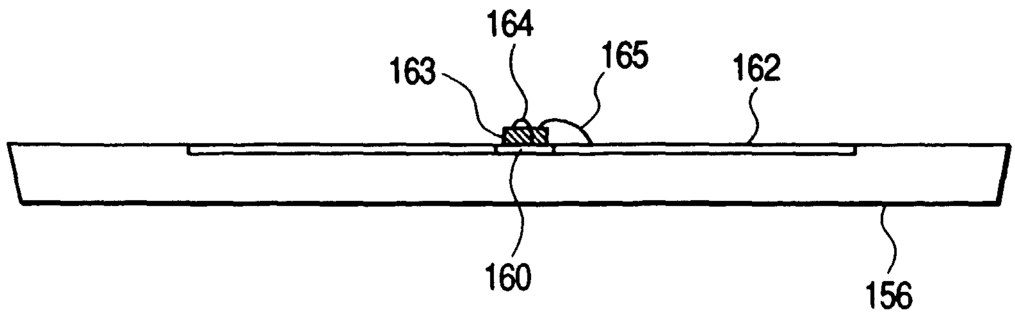


FIG. 31A

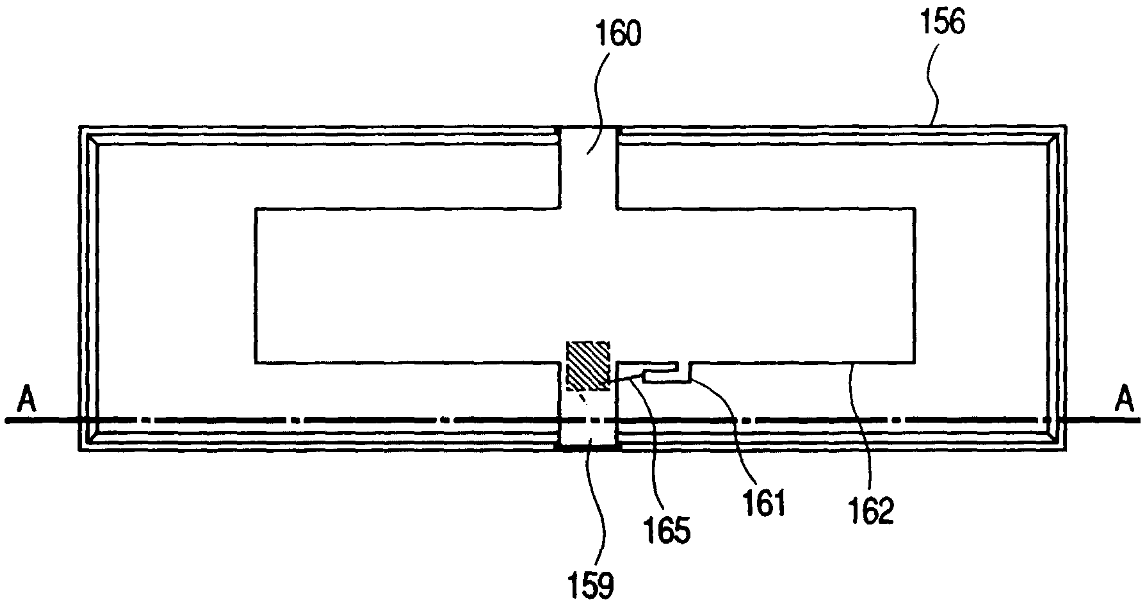


FIG. 31B

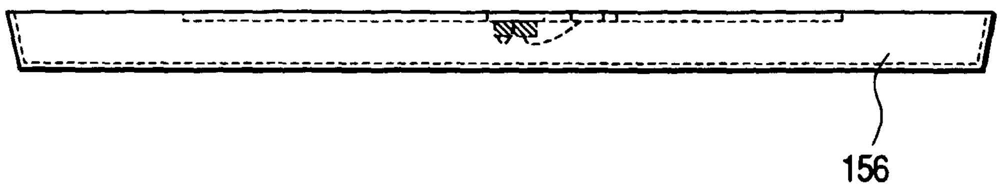


FIG. 32A

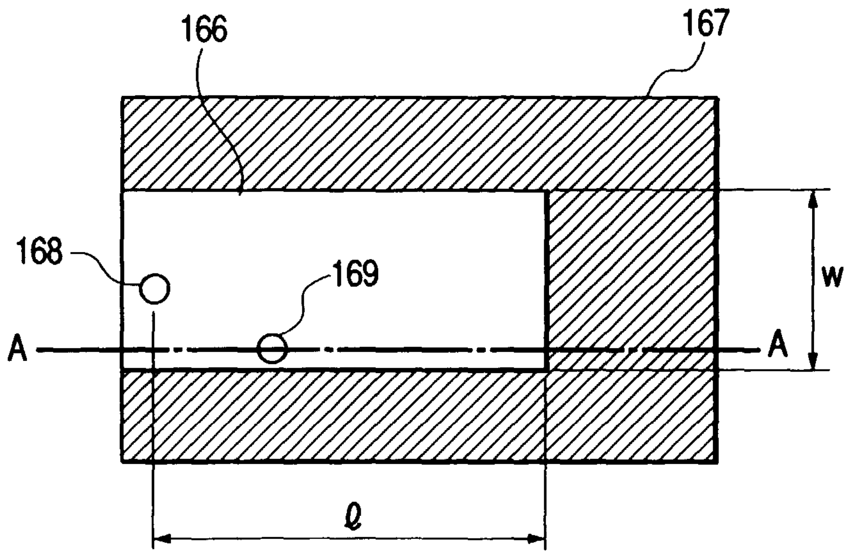


FIG. 32B

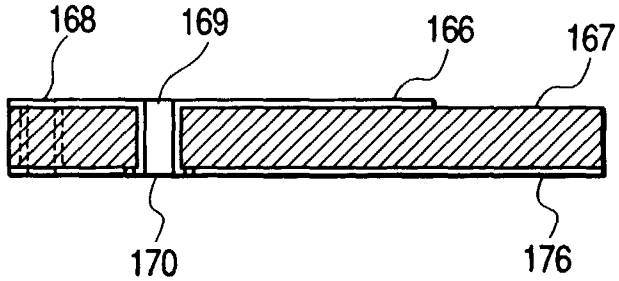


FIG. 32C

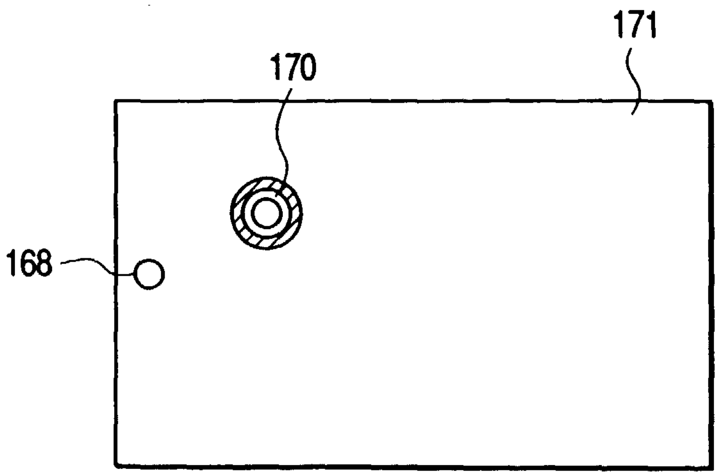


FIG. 33A

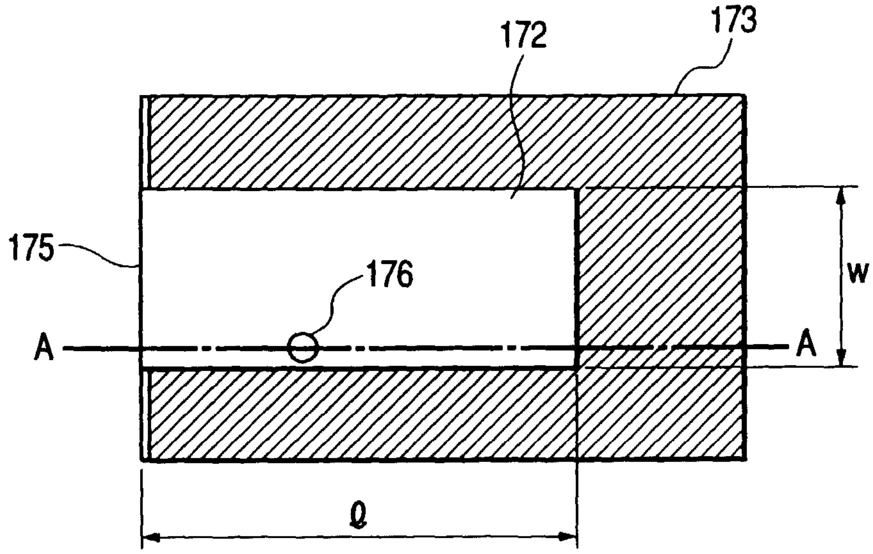


FIG. 33B

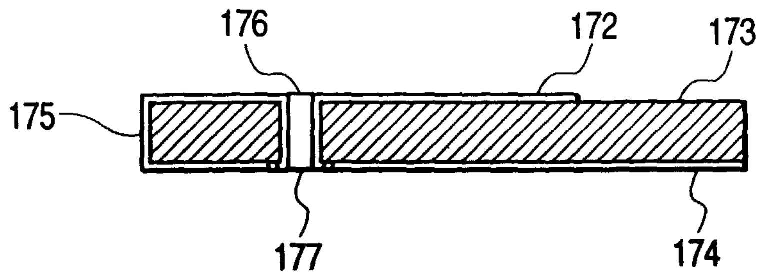


FIG. 33C

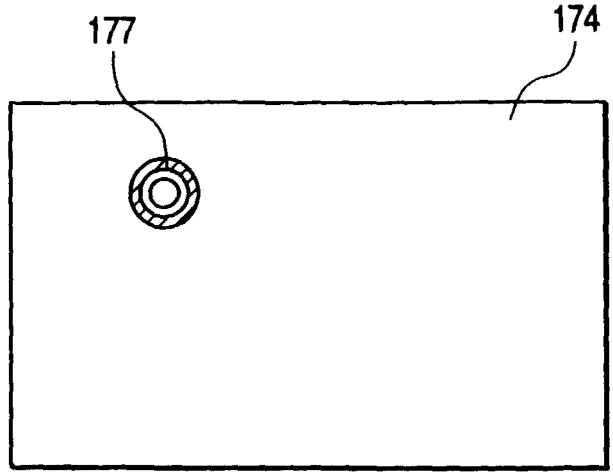


FIG. 34A

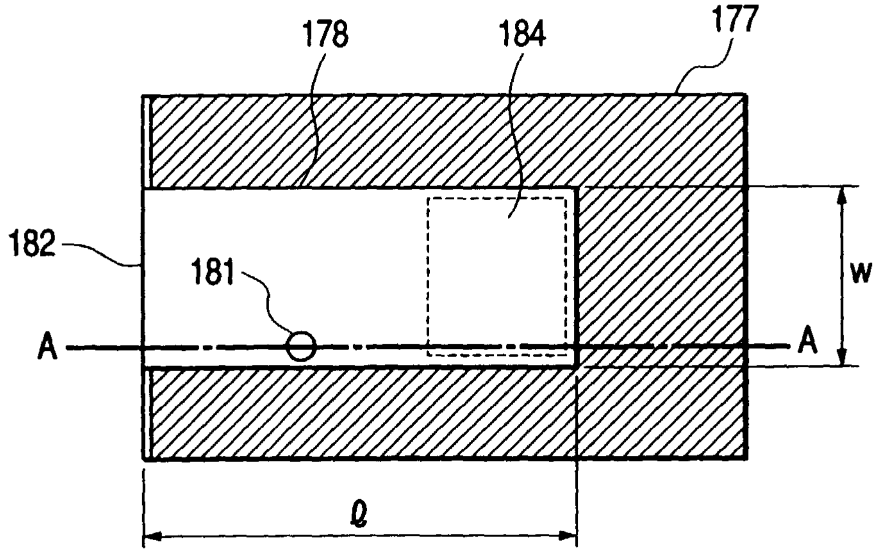


FIG. 34B

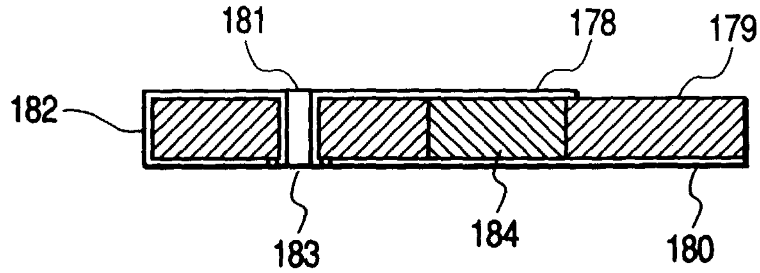


FIG. 34C

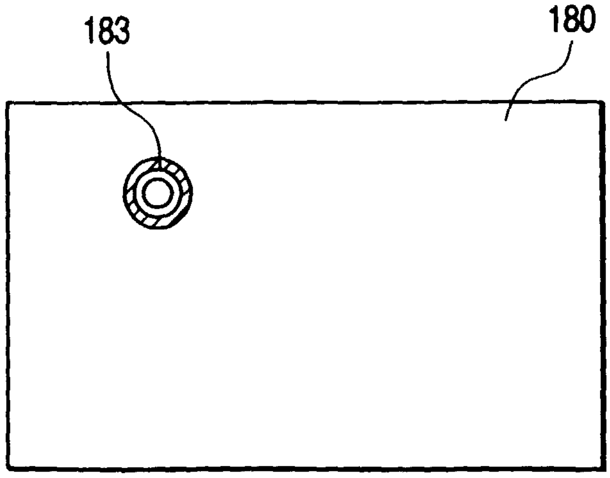


FIG. 35A

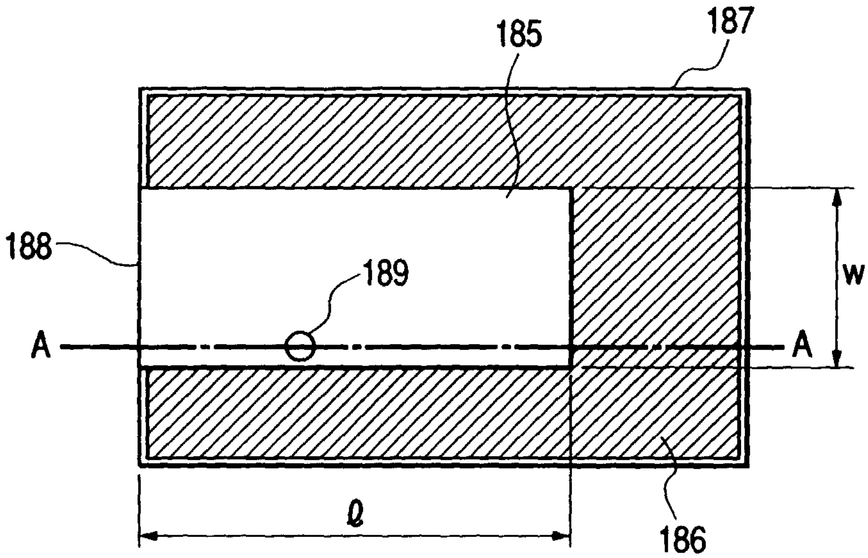


FIG. 35B

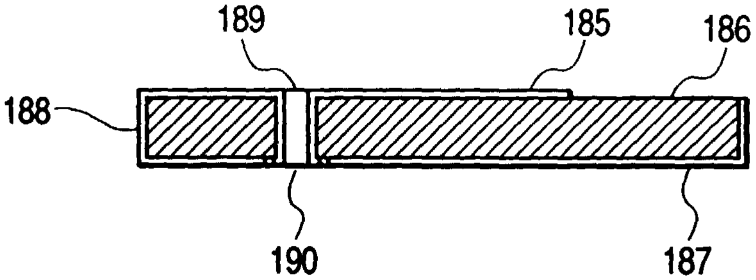


FIG. 35C

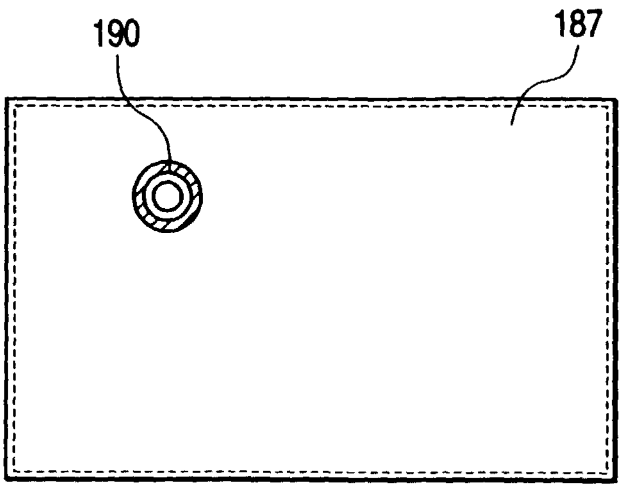


FIG. 36A

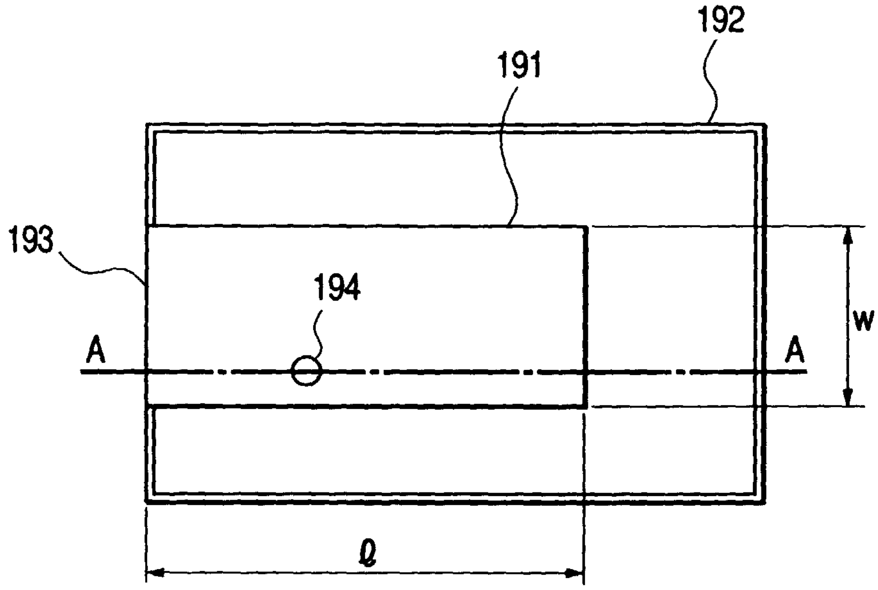


FIG. 36B

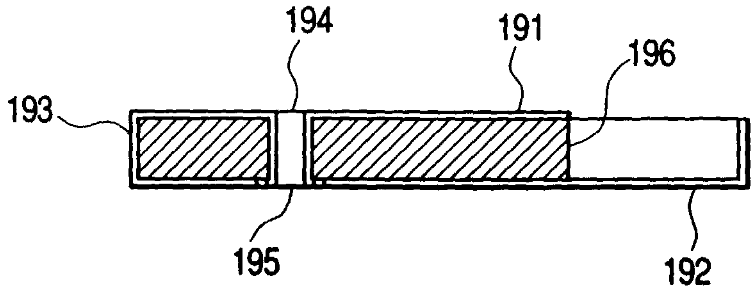


FIG. 36C

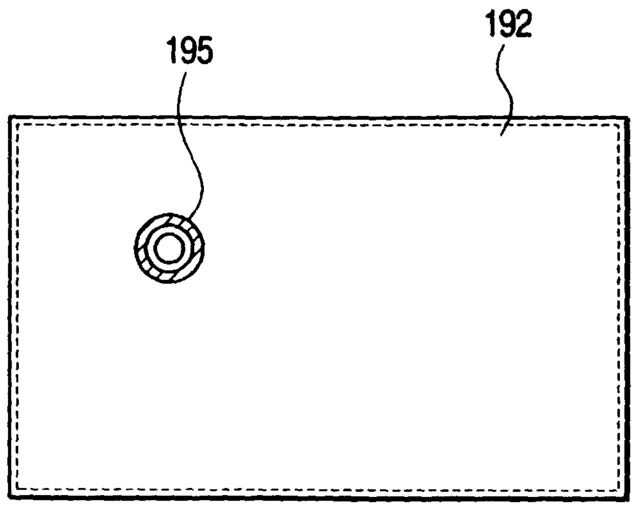


FIG. 37A

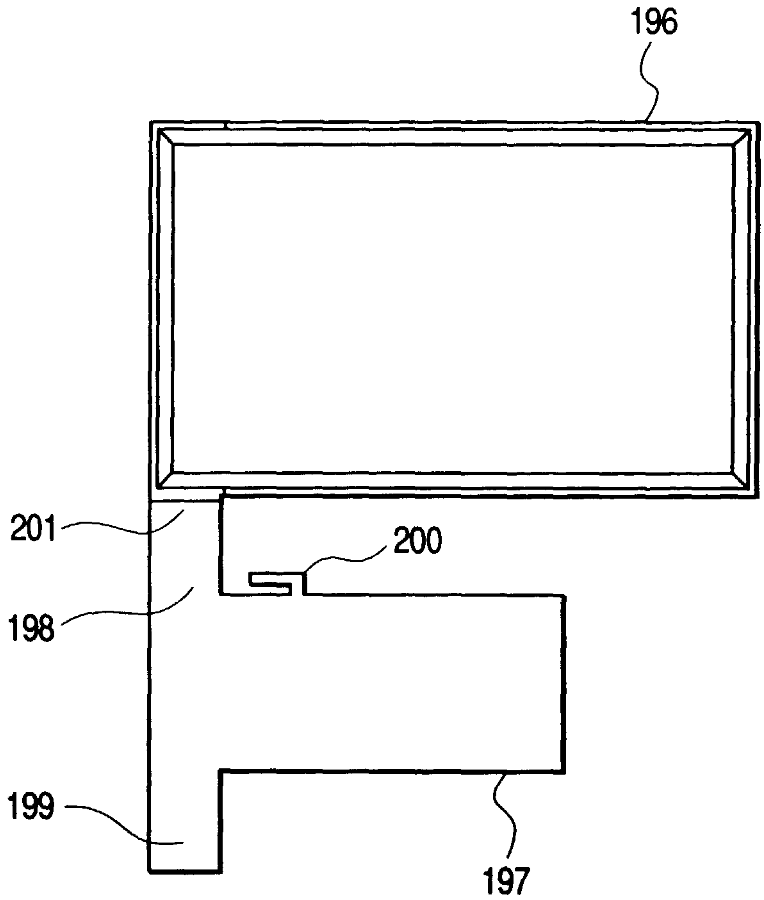


FIG. 37B

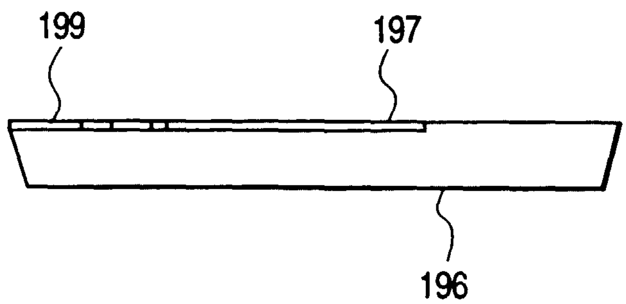


FIG. 38A

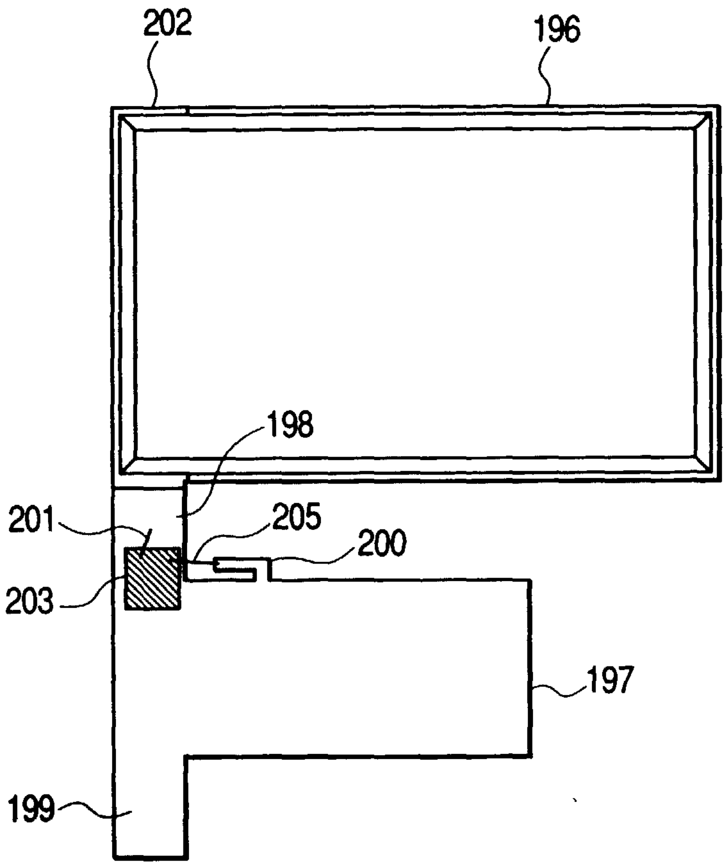


FIG. 38B

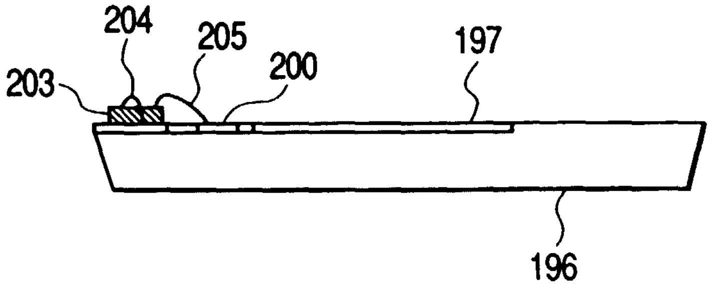


FIG. 39A

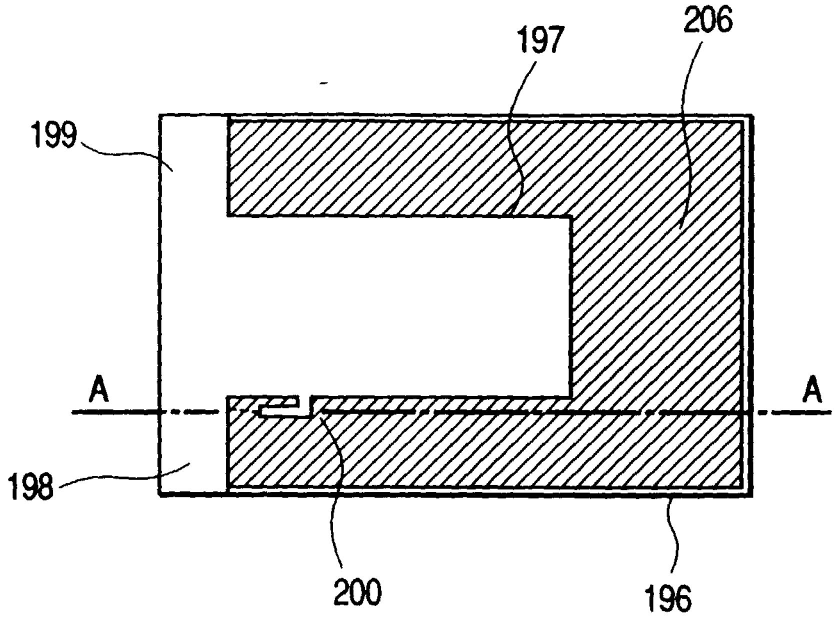


FIG. 39B

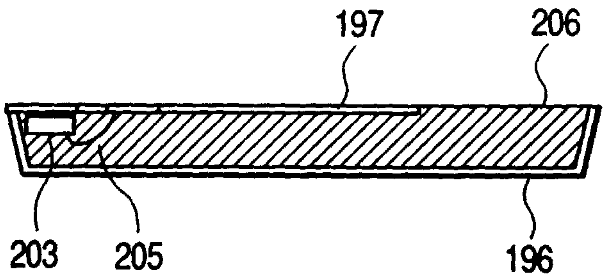


FIG. 39C

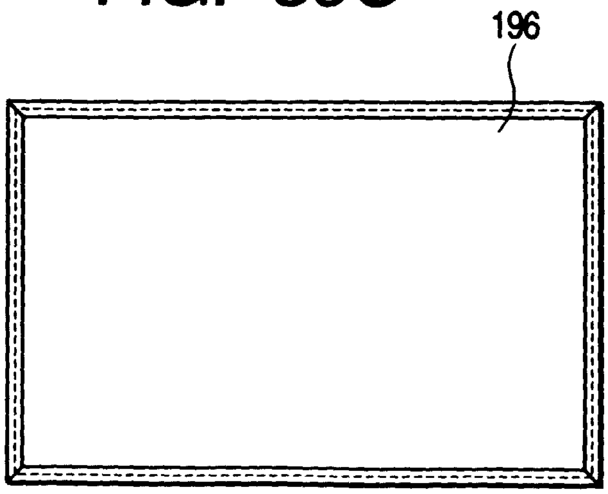


FIG. 40A

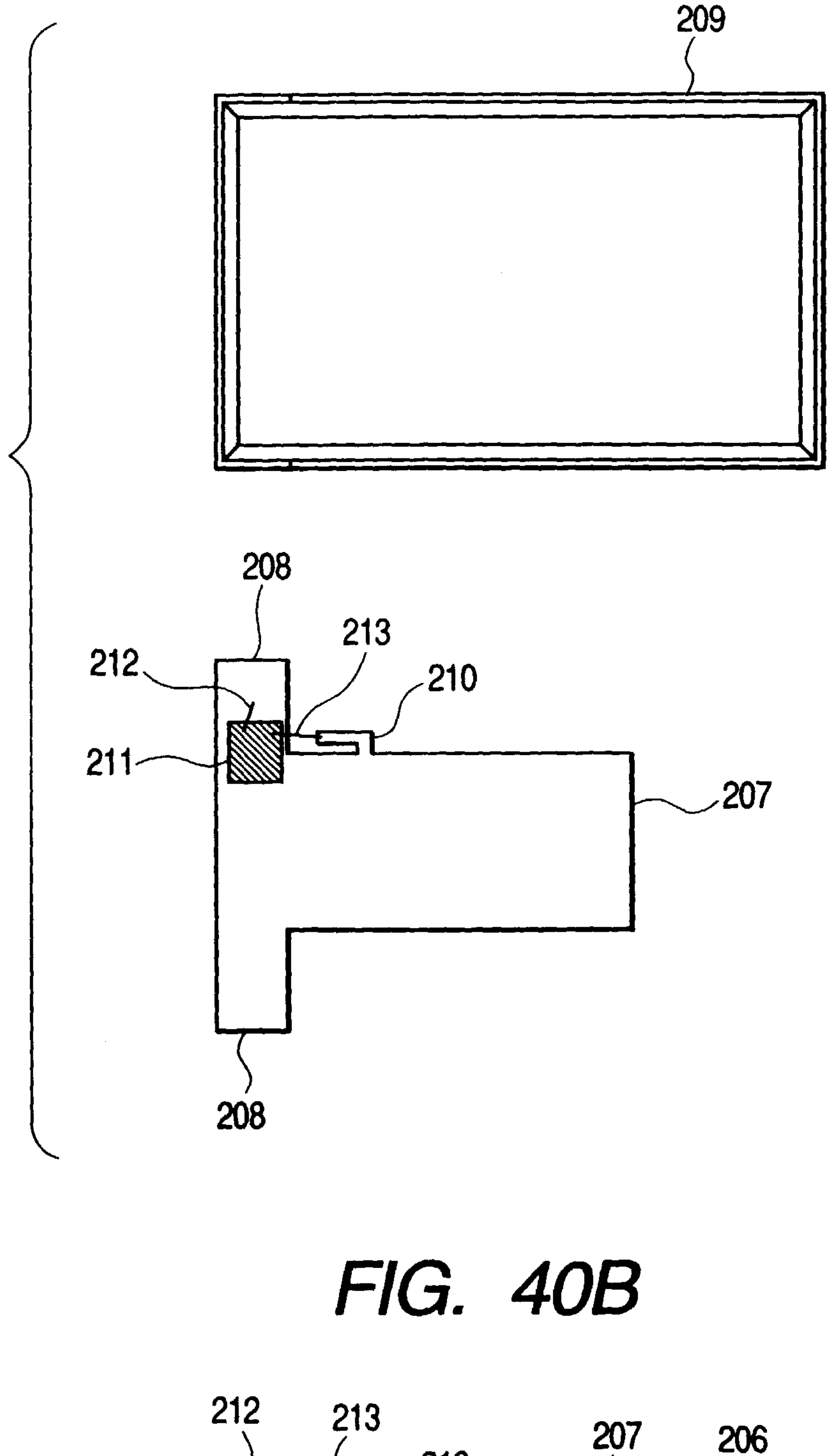


FIG. 40B

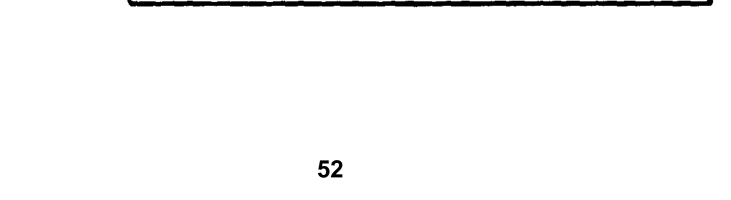


FIG. 41

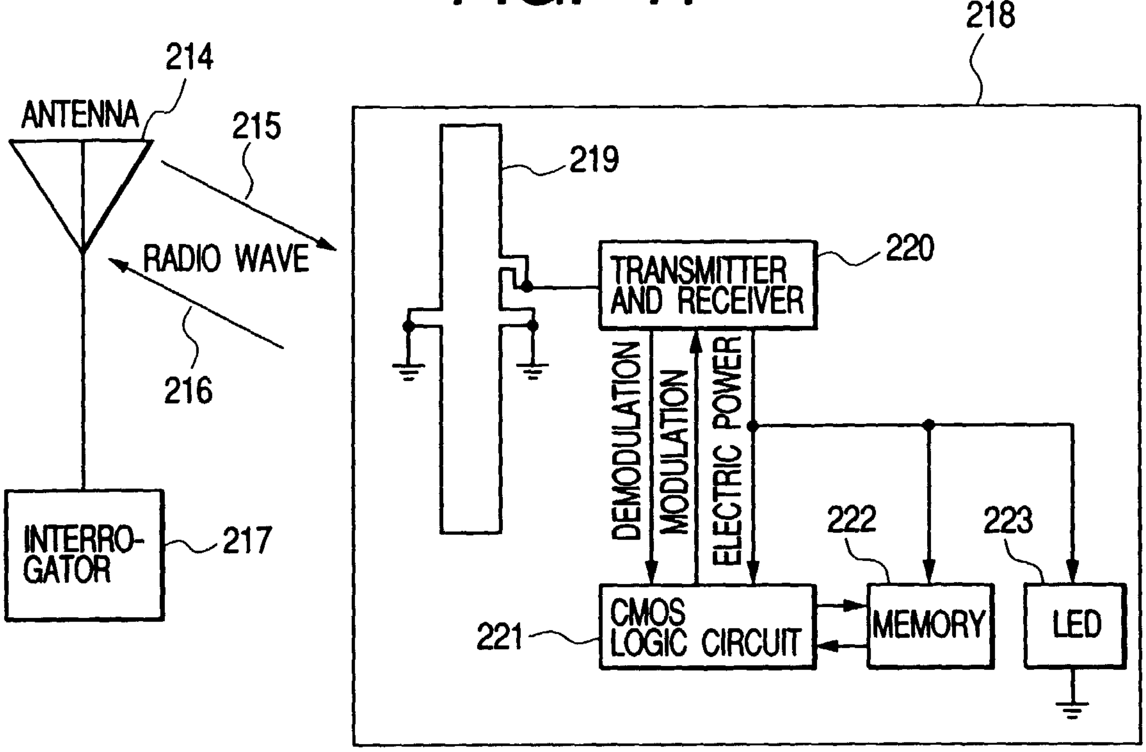

214
ANTENNA
215
RADIO WAVE
216
INTERRO-
GATOR
217
218
219
TRANSMITTER
AND RECEIVER
220
DEMODULATION
MODULATION
ELECTRIC POWER
222
223
CMOS
LOGIC CIRCUIT
221
MEMORY
LED

FIG. 42

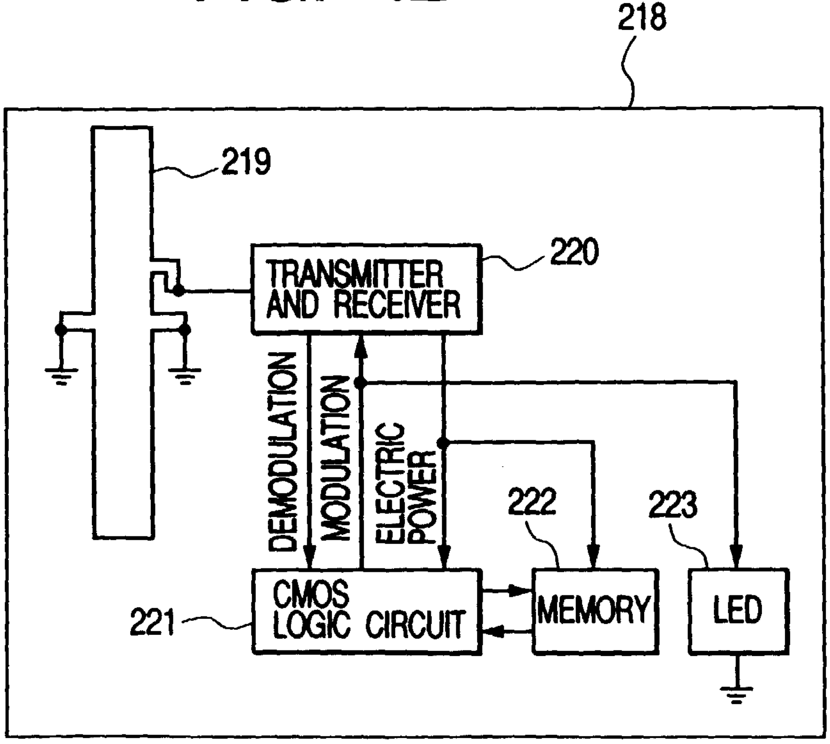

218
219
TRANSMITTER
AND RECEIVER
220
DEMODULATION
MODULATION
ELECTRIC
POWER
222
223
CMOS
LOGIC CIRCUIT
221
MEMORY
LED

FIG. 43

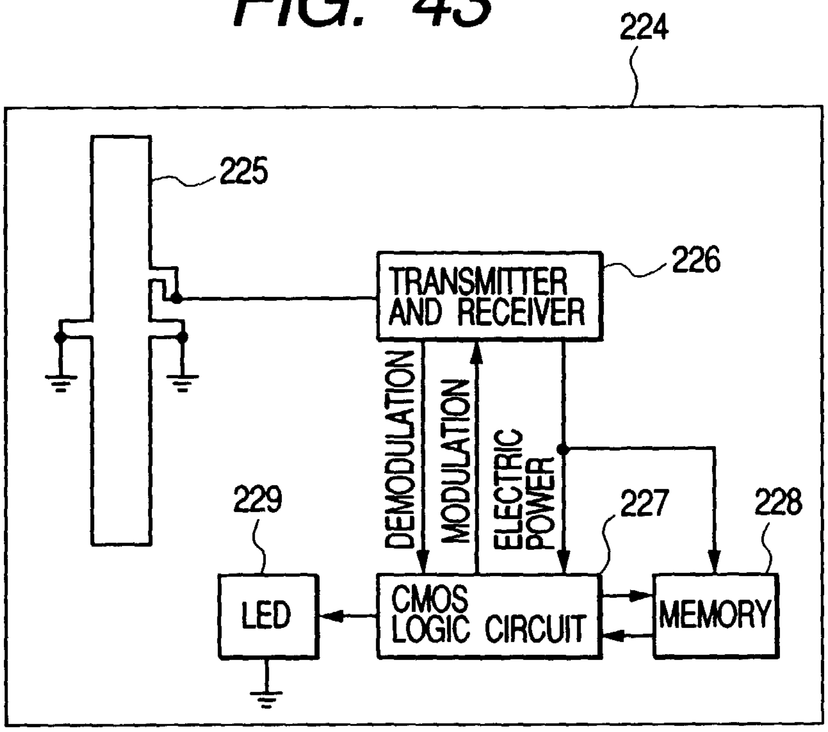
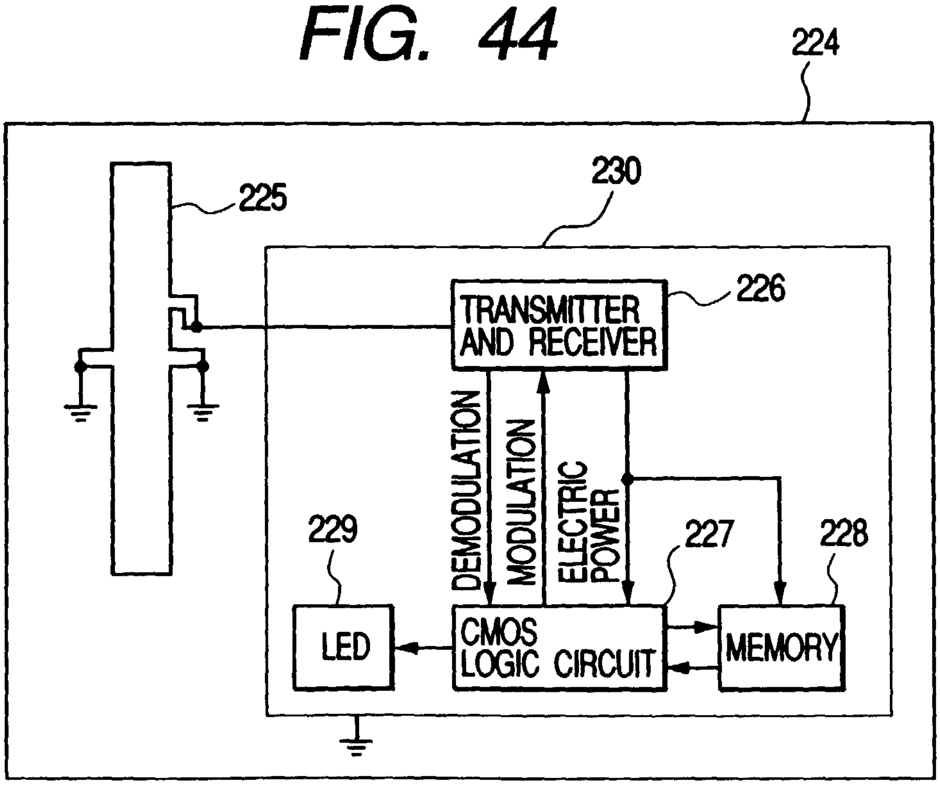

224
225
TRANSMITTER AND RECEIVER
226
DEMODULATION
MODULATION
ELECTRIC POWER
229
227
228
LED
CMOS LOGIC CIRCUIT
MEMORY

FIG. 44


224
225
230
TRANSMITTER AND RECEIVER
226
DEMODULATION
MODULATION
ELECTRIC POWER
229
227
228
LED
CMOS LOGIC CIRCUIT
MEMORY

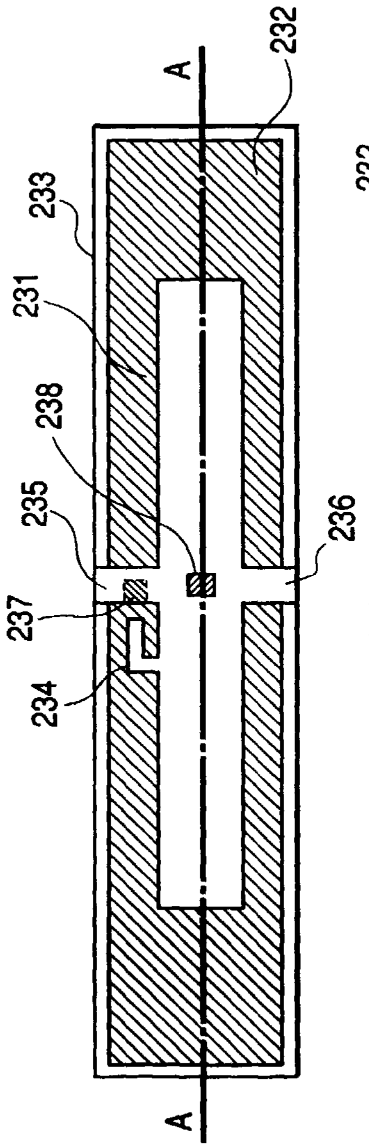


FIG. 45A

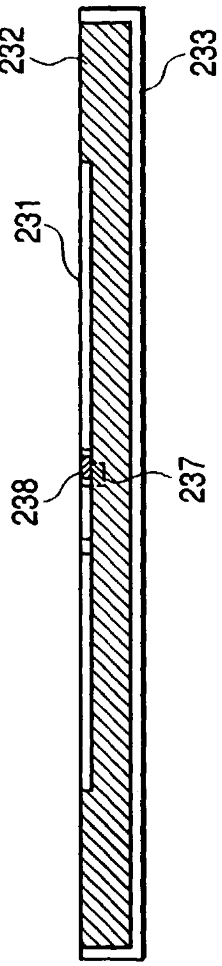


FIG. 45B

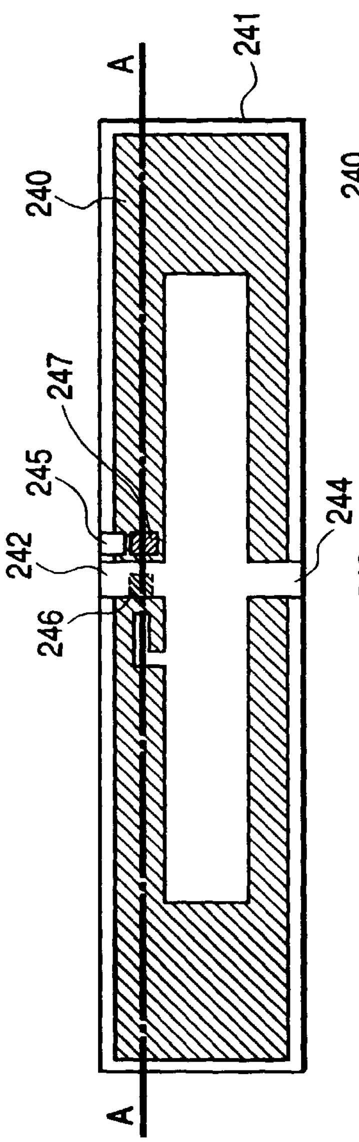


FIG. 46A

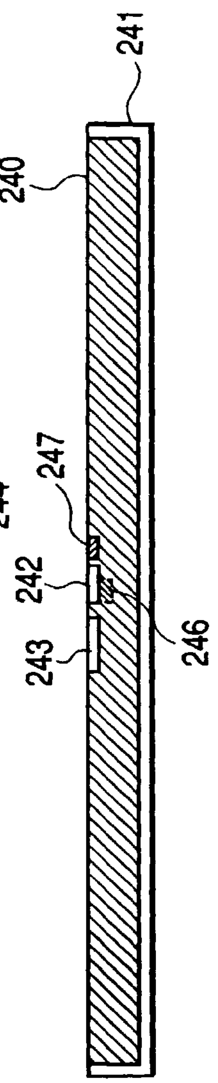


FIG. 46B

FIG. 47B

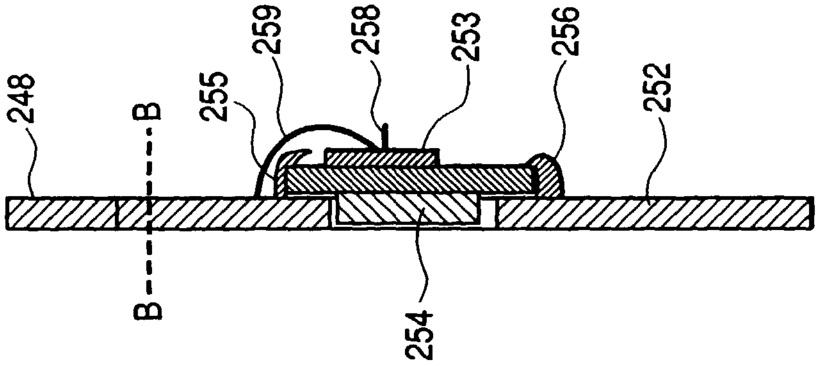


FIG. 47A